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THE DEPARTMENT OF ENERGY'S FY 1997 BUDGET REQUESTS FOR ENVIRONMENT, SAFETY AND HEALTH, ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT (NON-DEFENSE) AND NUCLEAR ENERGY

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The Department of Energy's FY 1997...

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE

U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTH CONGRESS

SECOND SESSION

MAY 1, 1996

[No. 72]

Printed for the use of the Committee on Science

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*Ranking Minority Member
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THE DEPARTMENT OF ENERGY'S FY 1997 BUDGET REQUESTS FOR ENVIRONMENT, SAFETY AND HEALTH, ENVIRONMENTAL RESTORATION AND WASTE MANAGEMENT (NON-DEFENSE) AND NUCLEAR ENERGY

WEDNESDAY, MAY 1, 1996

U.S. HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE,
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT,
Washington, DC.

The Subcommittee convened at 10:28 a.m. in room 2318 of the Rayburn House Office Building, the Honorable Dana Rohrabacher, Chairman of the Subcommittee, presiding.

Members present: Representatives Rohrabacher, Roemer, Fawell Baker, Doyle, Wamp, Foley, Olver, Ehlers Jackson Lee, Minge, McHale, Volkmer, Rivers and McCarthy.

Chairman ROHRABACHER. This hearing of the Energy and Environment Subcommittee will come to order.

Today is another in a series of hearings on the Department of Energy's Fiscal Year 1997 Budget Authorization.

Before making some opening remarks, I would like to bring the members of the Subcommittee up to date on the authorization schedule.

At last week's markup of the Omnibus Science Bill, Chairman Walker asked that the DOE authorization be considered separately by this Subcommittee after completing hearings on all the DOE programs under our jurisdiction. So far we have heard from the DOE's Chief Financial Officer as well as program heads for Fossil Energy, Energy Efficiency and Renewable Energy as well as the Fusion Energy Program.

Today's hearing and a hearing I have scheduled for May 8th will complete the process, and it is my intention to move on to a markup on the afternoon of May 15th.

It is my impression from Members' comments on both sides of the aisle that a majority of this Subcommittee would like to complete a new Authorization Bill, and I am proceeding on that assumption. I intend for the markup to be an inclusive process.

The Budget Committee is due to mark up this week, and that should give us some parameters with which to work. Within those parameters I welcome suggestions from all members of the Subcommittee on areas of particular interest. Suggestions will have more credibility if suggested increases are accompanied by suggested decreases in spending levels.

I believe our priorities should continue to be the funding of energy research and basis science programs, and my mark will reflect those priorities. However, we should still have enough flexibility to meet other Members' concerns even in the markup.

And let me also say as we move through this process and have votes of the Subcommittee, if the majority of the members of this Subcommittee have a different priority from the Chairman, that's what will be reflected in the final bill when we pass this out of our Subcommittee.

The only thing I'm asking for is for all of us to try at least to meet the goals, our budget goals that we've set before us and not simply try to increase the spending level, but if we have different priorities to set those priorities and say more money should be here and less money should go to another area.

Turning to today's hearing, we will first cover the Office of Environment, Safety and Health, and the Office of Environmental Management. Later we will hear witnesses on the request of the Office of Nuclear Energy. This Subcommittee has jurisdiction over the waste cleanup of non-defense sites, a small portion of the entire waste cleanup budget.

The Fiscal Year 1997 Administration request is I believe $651 million, which is a nine percent increase over the 1996 appropriation. The Environment, Safety and Health request of $112 million represents a six percent cut from the current appropriation level. The Office of Nuclear Energy is requesting $248 million for fiscal year 1997, and that also is a cut of 1.4 percent from the current funding.

Agency representatives will not be the only witnesses today. We will also hear from the GAO and the National Academy of Sciences. Both organizations have conducted recent studies on the DOE's waste cleanup program.

We will also hear from representatives of Citizens Against Government Waste and Public Citizen on continued funding of the Advanced Light Water Reactor Program, which should be an interesting discussion.

Although I believe that nuclear power provides a safe, clean energy source, I seriously question the continued use of scarce research dollars to pay for certification requirements and for the fees of major corporations, and this will be something we will be discussing.

Before I introduce our first panel, let me turn to my colleague from Indiana, the distinguished Ranking Minority Member, Mr. Roemer, for his opening remarks.

I apologize that we got started a half an hour late. There was a conference on the floor about a major issue in which Republicans had to make up our minds. We were discussing these things between ourselves, and I'm sorry that that caused us to be a little late this morning.

Mr. Roemer.

Mr. ROEMER. Thank you, Mr. Chairman. I ask unanimous consent to have my entire statement entered into the record.

Chairman ROHRABACHER. Without objection.

Mr. ROEMER. First of all, I would like to welcome our witnesses. I look forward to your testimony here this morning. I am particularly interested in discussing the efforts on behalf of the Department of Energy to move toward external regulation.

So I have a bill, H.R. 1510, that would move the Energy Department towards these external regulations by legislative direction, but I'm hopeful that we can hear some testimony from you today as to what your recommendations are and what progress you might see the Department making in this area in the future.

I'm interested in exploring aspects of the nuclear energy R&D budget. My statement gets into a host of other things, including some of the certification that the Chairman talked about with the light water reactor facility.

Chairman ROHRABACHER. Which side were you on?

Mr. ROEMER. I would like to engage our Chairman a little bit on what he opened and what he prefaced his remarks on, and that is the markup schedule for this Subcommittee. He indicated that this Committee is going to go to markup on the 15th.

Is that correct, Mr. Chairman?

Chairman ROHRABACHER. The 15th, yes.

Mr. ROEMER. It's the 15th. Now as many people here, Members know and people testifying know and people from the audience know, we've already marked up an Omnibus Energy Bill in Full Committee, and now we're saying that this Subcommittee, which is one of the crucial cornerstones of developing energy policy, is to make recommendations to the appropriators, to the science community and to the Senate. We are not going to even mark up our bill until the entire bill has been marked up in Committee and has gone to the floor on May 9th. Now I think we're moving very quickly toward making this Committee irrelevant.

Mr. Chairman, you and I have had talks on the Floor about this, and I am in no way insinuating or implying that you agree with this kind of strategy that might make this Committee irrelevant.

But this kind of strategy, whether it's on the part of the Chairman of the Full Committee or whether it's on the part of the consensus of this Committee, is quickly going to make those proponents that want to get rid of the Science Committee next year, which I strongly oppose, it gives them fuel for the fire to say when you cannot bring the energy component of this bill to Full Committee markup and to make that part of the Omnibus Bill, then maybe we should eliminate the Science Committee.

I think you just give the proponents who are trying to eliminate this Committee more and more logical arguments to get rid of it, and I am very, very upset about this, Mr. Chairman. I really think that this is like bringing an agriculture bill to the floor without the dairy component, like bringing a defense bill to the floor without the Air Force component, or bringing an education bill to the floor without the student loan component, and I really hope that we can talk this Committee and the majority party into including the entire part of the Committee's jurisdiction into an omnibus, what is called, what is purportedly and supposedly called an "omnibus bill."

As the Ranking Member of this Subcommittee, Mr. Chairman, I cannot convey to you how upsetting and how discouraging and disappointing this process is. So I hope that we can still work together in a bipartisan way. I know you and I will, but I hope this Subcommittee will continue to work together in a bipartisan way where we can make energy policy recommendations to the appropriators, to the United States Senate, to other people interested in the policy implications that we undertake in the deliberations of this Committee.

Certainly we're taking valuable time of these witnesses today, and if these people are testifying, and we're having people testify this week and next week, are we wasting their time when this Subcommittee is not going to be taken seriously by the Full Committee and we're not going to be part of the Omnibus Bill?

It's surprising to me that the Washington Post lists this Committee and our deliberations here in the paper this morning. I'm surprised that our distinguished expert panelists showed up, and I wonder if we can continue to get people to show up for Committee hearings when this Committee is left out of the process, Mr. Chairman.

With that in exasperation and in frustration I would yield back any time I have remaining.

Chairman ROHRABACHER. The Chairman takes note of that very justified criticism, and recognizing that it's not this Chairman's decision that he's criticizing.

Let me note for the Committee that we do have 10 minutes reserved for opening remarks. I would invite other Members to submit their remarks for the record. Usually we just open it up for the Ranking Member as well as the Chairman to speak for their sides of the aisle.

Is there anyone who would like to submit something for the record?

[No response.]

If not, our first panel will cover the Offices of Environment, Safety and Health and Environment Management.

Peter Brush is the Principal Deputy Assistant Secretary for Environment Safety and Health at the Department of Energy.

Rear Admiral Richard Guimond serves in the same role for the Office of Environmental Management.

Bernice Steinhardt is Associate Director of Resources, Community and Economic Development Division for the General Accounting Office.

And Dr. E. William Colglazier is Executive Officer for the National Academy of Sciences and National Research Council.

So without further ado and without objection, your entire testimony will be submitted for the record. I would just ask if you could summarize in a five-minute segment. That will give time to the members of the Committee to follow-up and ask questions.

Mr. Brush.

STATEMENT OF MR. PETER N. BRUSH, PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR ENVIRONMENT, SAFETY AND HEALTH, U.S. DEPARTMENT OF ENERGY, WASHINGTON, DC

Mr. BRUSH. Thank you very much, Mr. Chairman.

I appreciate the opportunity to join my colleagues here to discuss the Department of Energy's fiscal 1997 budget request for the Office of Environment, Safety and Health.

Mr. Chairman, the Office of Environment, Safety and Health is the central office in the Department of Energy dedicated to protecting the safety and health of more than 100,000 workers as well as the public living near our facilities and the environment around our facilities.

Considering this compelling mandate, I think you will agree that our budget request of $176 million represents a fair allocation of resources in these difficult budgetary times. Our request is one percent of the Department's entire budget, and it is about eight percent below last year's level.

This pared-down budget request is the result of a serious commitment by our office to meet our obligations while satisfying calls for greater efficiencies. We are reducing reliance on support service contractors, we are consolidating training and other administrative functions, and at the same time we are boosting our ability to enhance safety at DOE through a reorganized program and a strategic plan that focuses our resources on making DOE safer.

In creating our program, Mr. Chairman, we have benchmarked ourselves against major U.S. corporations, from Dow Chemical to U.S. Steel to Union Carbide, all of which recognize the need for a strong internal environment, safety and health organization focused on providing a safe workplace through prevention, and I underscore prevention, of accidents, illnesses and environmental damage.

These corporations have recognized that safety is an investment that allows us to target our most urgent risks, use our limited resources most efficiently and do our work most effectively.

The need for such a program was recently recognized by the Advisory Committee on External Regulation of DOE nuclear facilities which pointed out that a strong internal DOE safety management system will be essential under any regulatory regime.

We need such a program, Mr. Chairman, because the Department is responsible for managing and disposing of enormous quantities of radioactive and other hazardous materials and the contaminated soils and groundwater around our facilities.

This includes 26 metric tons of plutonium that had previously been recycled into warheads. Some of this is now left in containers in facilities in conditions not suited for long-term storage. Other inventories include about 2,700 metric tons of spent reactor fuel, more than 430 metric tons of other radioactive materials and more than 1.9 million cubic meters of radioactive waste.

In describing and summarizing our program I want to mention three major program areas of the Office of Environment, Safety and Health—independent oversight, health studies and technical assistance.

Mr. Chairman, we manage a comprehensive program of independent oversight of the Department's facilities and activities. These assessments provide to DOE management validated professional appraisals of a site's performance, greatly aiding the program's ability to target resources to areas of greatest risk, to workers, the public and the environment. These assessments have identified where we're doing well, where we have to work harder, and they also aid in spreading the good practices at one site amongst the various Department of Energy facilities.

I also want to point out that our budget request for oversight includes funds to continue to implement the Price-Anderson Act

Amendments of 1988 which gave to the Department of Energy the authority to enforce nuclear safety rules and issue civil penalties on its contractors for violation of those nuclear safety rules. I'm pleased to say that program is now up and running effectively. We have issued two major rules, and recently issued our first enforcement action in the form of a Notice of Violation against one of the Department's contractors.

We intend to further strengthen our Price-Anderson enforcement program in the coming fiscal year to add Federal staff to that effort and elevate the office so that it reports directly to the Assistant Secretary for Environment, Safety and Health.

Our second major program area that I want to mention is health studies. Our Office of Health Studies sponsors domestic and international studies to increase our understanding of radiation health effects and the environmental and occupational health impacts of DOE operations.

Some examples of this program are the State Health Agreements Program, our programs for epidemiological surveillance and our agreement with the Department of Health and Human Services under which we foster significant scientific studies of safety and health around our facilities.

Finally, under health studies, Mr. Chairman, let me mention the Radiation Effects Research Foundation which we jointly support with the government of Japan in studying the health effects on the Japanese atomic bomb survivors. Ongoing programs at RERF include studies of the effect of atomic bomb radiation on the health of survivors, studies on whether the lifespan and causes of death of atomic bomb survivors differ from those of unexposed individuals and studies of generic effects.

We have underway, Mr. Chairman, a distinguished Blue Ribbon Panel looking at the RERF over the course of this past year, since the RERF is in fact the single largest budget element in our budget for the Office of Environment, Safety and Health.

Finally, the third major part of our program, Mr. Chairman, is our Program of Technical Assistance. Like any major corporate resource, the Department of Energy needs a program which focuses on providing to Federal managers the tools they need to improve safety or management systems that are especially important when you have hazards such as we have at the Department of Energy.

This program provides specialists to advise and work with Department line programs on matters of environment, safety and health following the tenet that the essence of protecting environment, safety and health at DOE sites is effective work planning, hazard analysis and hazard control.

Simply put, Mr. Chairman, accidents cost money. DOE paid out some $500 million in worker compensation over the past 10 years. Considerably more has been lost to medical costs and lost productivity, much of which could be saved by effective work planning and hazard analysis.

Our experience suggests that an effective Technical Assistance Program will reduce workplace risks, will reduce the need for compliance-based regulation and will reduce costs; and we've provided to the Committee a complete list of the savings that we believe can be achieved through an effective Technical Assistance Program.

Mr. Chairman, I'm going to stop there in light of time and ask again that my complete statement be included for the record.

Thank you very much.

Chairman ROHRABACHER. Yes, that will be included in the record without objection, and thank you very much for summarizing your position.

[The prepared statement of Mr. Brush follows:]

Statement of

Peter N. Brush

Principal Deputy Assistant Secretary

Environment, Safety and Health

Department of Energy

before the

Subcommittee on Energy and Environment

Committee on Science

May 1, 1996

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to join my colleagues to discuss the Department of Energy's (DOE) Fiscal Year 1997 budget request for the Office of Environment, Safety and Health.

The Office of Environment, Safety and Health (EH) is the single office in DOE that is dedicated to protecting the safety and health of more than 100,000 workers, the public living near our facilities, and the environment. Considering this compelling mandate, I think you will agree that our budget request of $176 million represents a fair allocation of resources in these difficult budgetary times. Our budget request is one percent of the Department's entire budget and about eight percent below last year's level. It also represents a continuing downward trend in spending beginning with our Fiscal Year 1993 level of spending of $228 million. We expect that trend to continue.

This pared-down budget request is the result of a serious commitment by our office to meet our obligations while satisfying calls for greater efficiencies. We have been able to achieve such efficiencies by leveraging resources wherever possible, reducing reliance on support contractors and consolidating training and other administrative functions. At the same time, we have been able to boost our ability to enhance safety at DOE through a reorganization and strategic plan that focused our resources on "making DOE safer."

As you will see in my testimony, these efforts are now beginning to pay off. It is my hope that the Committee members will agree with me that this is a bare-bones budget, and that any further reductions will seriously compromise our ability to protect the health and safety of the workers and the public at a time when the Department of Energy's operations have never been more hazardous.

Major industrial U.S. corporations -- from Dow Chemical to U.S. Steel to Union Carbide -- recognize the need for a strong, internal organization focused on providing a safe workplace through the prevention of accidents, illnesses, and environmental damage. These corporations have recognized that safety is an investment that allows us to target our most urgent risks, use our limited resources most efficiently, and do our work most effectively. The industrial complex managed by the Department of Energy -- with hazards far more serious than any U.S. corporation -- requires no less. In recommending that the Department maintain a focused "corporate" safety function separate from line program management once it comes under external regulation, the Advisory Committee on External Regulation of DOE Nuclear Facilities point out that "a strong internal DOE safety management system is essential under any regulatory regime and, for that reason, the transition to external regulation must be done carefully so that it does not disrupt efforts already underway to strengthen and streamline that system."

The Committee will note that the FY 1997 EH budget has been changed to reflect the major business lines identified in our strategic plan. The major business lines are Technical Assistance, Oversight, and Health Studies.

Serious and Compelling Hazards

As we discussed with the Committee last year, Mr. Chairman, no corporation or government agency has ever been faced with a greater challenge to worker safety and health. That remains true today. The continuing shift to dismantlement, decommissioning and stewardship followed by cleanup, waste management and disposal is dramatically changing the nature of the DOE complex. Many facilities themselves, old and deteriorating, present serious threats to those who must work in or around them. The Department lacks reliable data for many of these facilities, such as how they were constructed, the nature of past uses, inventories of hazardous materials, or even the status of electrical and ventilation systems.

Today the Department is responsible for managing and disposing of enormous quantities of radioactive and other hazardous materials and contaminated soils and ground water. This includes 26 metric tons of plutonium that had previously been recycled into warheads that are now left in containers and facilities in conditions not suited for safe long-term storage. Other inventories include about 2700 metric tons of spent reactor fuel, more than 430 metric tons of other radioactive materials, and more than 1.9 million cubic meters of radioactive waste. DOE facilities have improperly tracked, stored, and disposed of large quantities of hazardous chemical and radioactive materials, creating threats of unplanned chemical reactions, workers exposures, environmental releases, or criticality.

Workers and managers at DOE sites are often not properly prepared to take on such a task. The dramatic mission changes present DOE workers with tasks unfamiliar to many and with highly dynamic workplaces where hazards can be numerous and varied, and exposures difficult to predict.

Technical Assistance

In 1995 the Office of Environment, Safety and Health reengineered itself into an organization focused on the explicit goal of making DOE safer. Strategic planning revealed that the organization had been overly focused on day-to-day oversight of DOE's operating contractors, often with several layers of duplication. Long lists of non-compliances with outdated rules and orders were not producing a safer workplace. What was lacking was a program focused on providing federal managers the tools they need to improve safety, management systems that are especially important when hazards are dynamic, complex and of high consequence. That effort has become the Technical Assistance program.

In the brief time since its establishment, the EH Technical Assistance program has paid off time and again in terms of enhanced safety, enhanced productivity, and millions of taxpayer dollars saved.

Specialists in DOE's Technical Assistance program advise and work with the department's line programs on matters of environment, safety and health. They are trained and skilled at promoting a new paradigm of safety and health that has as its fundamental tenet that the essence of protecting environment, safety and health at DOE sites is effective work planning, hazard analysis and hazard control. Simply put, accidents cost money; DOE paid out some $500 million in workers' compensation over the past ten years; considerably more has been lost to medical costs and lost productivity -- all of which could have been saved by effective work planning and hazard analysis.

Our experience strongly suggests that an effective technical assistance program will ultimately reduce workplace risks, the need for compliance-based regulation, and cost. Through several joint projects, we have shown that we can do our work better, more safely, and at less cost by integrating safety into the planning and execution of our work. At Fernald, for example, we avoided nearly $2 million in costs by recognizing and avoiding unnecessary work because safety personnel worked side by side with engineers, planners, and other workers to "build in" safety and health concerns into the planning of work. A more complete list of money-saving accomplishments is attached. We expect this "enhanced work planning" approach to become standard practice throughout the DOE complex and continue to save taxpayers millions of dollars year after year while also making work safer.

Another effective safety tool is the ongoing development of the "Necessary and Sufficient Process" -- a graded approach to safety standards that gets us away from "top down" regulation and tailors safety standards to actual work. In a pilot application at a major Hanford facility, we were able to greatly reduce worker exposure while cutting costs by 50 percent. We hope to use this process to proceed with safe and timely stabilization of facilities at Rocky Flats and other locations throughout the DOE complex.

Independent Oversight

Comprehensive assessments provide DOE management with validated, professional appraisals of a site's performance, greatly aiding the program's ability to target resources to areas of greatest risk to workers, the public, and the environment. The foundation of the new approach is an analytic framework or "template" that clearly articulates the principles and operational elements of sound ES&H management programs. The assessments have identified where we're doing well, where we have to work harder, and also aid in spreading good practices among our sites.

Oversight findings are published in publicly-available reports. The intent is to use focused, disciplined analyses to hold managers accountable for safety in a way that is fair and effective while providing information and analyses that illuminate safety trends in ways that help managers make better decisions about priorities and resource allocations. Site residents are posted full-time at major DOE sites to observe and analyze safety performance on a day-to-day basis. In addition to daily duties, DOE site residents conducted more than 200 site surveillances at facilities in 1995.

This information is compiled and analyzed to produce "site profiles -- integrated pictures of the status of safety at any particular site. These profiles describe site activities and identify potential hazards. They also summarize key site-wide and facility-specific safety issues and provide an overall evaluation of the effectiveness of safety. The continually updated profiles provide senior managers with a ready source of "real-time" information about the site.

Our budget request for oversight also includes funds to continue to implement the Price Anderson Act Amendments of 1988 which gave the Department the authority to enforce nuclear safety rules and issue civil penalties on its contractors for violations of nuclear safety rules. Although the requirements of formal rulemaking forced us into a slow start, the program is now up and running quite effectively. We have issued two major rules and recently issued our first enforcement action in the form of a Notice of Violation against Pacific National Laboratories.

We intend to further strengthen our Price-Anderson enforcement program in the coming fiscal year. We have plans to add additional federal staff to the enforcement effort and elevate the office so that it reports directly to the Assistant Secretary for Environment, Safety and Health.

Health Studies

The Office of Health Studies sponsors domestic and international studies to increase our understanding of the radiation health effects and the environmental and occupational health impacts of DOE operations. Investigations of the relationships between exposures to radiation and chemicals and consequent health effects among populations is a critical public health function that is key to designing effective strategies.

State Health Agreements. Grants are awarded to states that host DOE facilities to determine the impact of those facilities on the health of the surrounding communities. The activities being conducted under these grants include epidemiologic feasibility studies, environmental dose reconstruction projects, tumor and birth defects registries, and preliminary descriptive epidemiologic investigations. All grant applications undergo merit review by peer reviewers external to the DOE. The Department has awarded grants to California, Colorado, Florida, Idaho, New Mexico, South Carolina, and Tennessee.

- Epidemiologic Surveillance. This program tracks the occurrence of illnesses and injury of more than 65,000 Department of Energy contract employees at 10 -- Brookhaven National Laboratory, Fernald, Hanford, Idaho National Engineering Laboratory, Kansas City, Lawrence Livermore National Laboratory, Pantex, Rocky Flats, Sandia National Laboratory, and Savannah River Site. Data are analyzed to determine the rates of illness and injury among the current workforce in order to identify workplace conditions that may pose a health threat to workers. Illness and injury surveillance data are shared with workers, occupational physicians, labor unions, DOE management, and other government officials in the form of reports, meetings, and written responses to questions about the health status of DOE workers. The epidemiologic surveillance reports are placed in

DOE public reading rooms and will soon be electronically accessible through the Internet.

- Agreement With Department of Health and Human Services. DOE has established an external epidemiology program through a Memorandum of Understanding (MOU) with the Department of Health and Human Services. Research currently being conducted under this MOU by the Centers for Disease Control and Prevention include: epidemiologic studies of contractor employees at selected DOE facilities (e.g., Idaho National Engineering Laboratory and Rocky Flats Plant), a combined study of female employees at 19 sites and facilities; environmental dose reconstruction projects at selected sites (e.g., Fernald Environmental Management Project, Hanford Site, and the Savannah River Plant); and studies of childhood cancer in communities near DOE facilities (e.g., Hanford).

Radiation Effects Research Foundation.

The United States and Japan jointly support studies of the health effects of radiation on the Japanese atomic bomb survivors at the Radiation Effects Research Foundation in Hiroshima and Nagasaki, Japan. Ongoing programs at the Radiation Effects Research Foundation include studies of the effects of atomic bomb radiation on the health of survivors, studies on whether the lifespan and causes of death of atomic bomb survivors differ from those of unexposed individuals, and studies of genetic effects in children born to atomic bomb survivors.

Annual funding for the Radiation Effects Research Foundation is provided equally by the Government of Japan, through the Ministry of Health and Welfare, and by the United States Government, through the Department of Energy. Funding is provided in yen by both countries. The Department of Energy's support of the Foundation and its mission is reflected in the one-third of a billion dollars contributed over the past 50 years. The Department of Energy's annual contribution for each of the past four years, including the amount allocated to the National Academy of Sciences, has been about $20 million.

In 1995, at the request of the Radiation Effects Research Foundation's Scientific Council, an international group of scientists was empaneled to independently assess the Foundation's current and future scientific activities. This Blue Ribbon Panel will issue its final report in June 1996. The Japanese government feels strongly that the recommendations on the future of clinical and genetic studies should take into account the direct benefits of the Radiation Effects Research Foundation on the health of the atomic bomb survivors and their children.

Members of this Committee should be aware that the United States budgetary constraints, along with the declining value of the dollar versus the yen over the past decade, have made it difficult for the Department of Energy to continue funding fifty percent of the Foundation's operations. The Radiation Effects Research Foundation is the largest line item in the Office of Environment, Safety, and Health budget, yet our budget request is still insufficient to co-fund the United States' share of the Foundation's proposed $40 million budget for Japanese FY 1996 (beginning April 1, 1996).

The FY 1996 Energy and Water Appropriations Bill directed the Administration to work with the National Academy of Sciences and the Japanese government to achieve cost savings to reflect United States budgetary constraints. The Department has been and will continue working with the National Academy of Sciences and the Japanese to institute a funding plan for upcoming years that will preserve the core of the Foundation's science program while taking into account United States funding limitations. The Department will look to the International Blue Ribbon Panel to help define the key elements of the Foundation's scientific mission that should continue to be supported.

Mr. Chairman, this brief statement and its attachment highlights some of the recent accomplishments we have made in the Office of Environment, Safety and Health and outlines our plans for the coming year. I would be happy to answer any questions.

DEPARTMENT OF ENERGY
FY 1997 CONGRESSIONAL BUDGET REQUEST
ENVIRONMENT, SAFETY and HEALTH
ORGANIZATION FUNDING PROFILE[1]

Sub-Program	FY 1995 Comparable Appropriation	FY 1996 Comparable Appropriation	FY 1997 Budget Request
EH Non-Defense			
Operating Expenses			
Technical Assistance	$34,419	$34,180	$29,220
Policy	2,560	2,600	2,340
NEPA	3,500	3,410	3,500
RERF	18,000	20,000	15,000
Management and Administration	24,701	24,100	23,100
Program Direction	45,113	39,315	39,046
Subtotal	128,293	123,605	112,206
Adjustment	0	-4,396	0
Subtotal Non-Defense	$128,293	$119,209	$112,206
EH Defense			
Operating Expenses			
Oversight	$18,300	$16,245	$14,526
Health Studies	41,767	41,645	38,568
Program Direction	10,810	11,766	10,706
Subtotal	70,877	69,656	63,800
Adjustment	- 6,600	0	0
Subtotal Defense	$64,277	$69,656	$63,800
TOTAL	$192,570	$188,865	$176,006

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[1] Under the new budget structure, net shift of $13,549,000 in FY 1995 and $9,332,000 in FY 1996 from Energy Supply, Research and Development. The FY 1995 and FY 1996 columns are displayed in the new structure for comparison purposes only; the FY 1995 and FY 1996 programs are being implemented as appropriated.

Authorizations:
P.L. 83-703, "Atomic Energy Act of 1954"
. 100-408, "Price Anderson Amendments Act of 1988"
P.L. 95-91, "Department of Energy Organization Act" (1977)

Chairman ROHRABACHER. Admiral.

STATEMENT OF REAR ADMIRAL RICHARD J. GUIMOND, PRINCIPAL DEPUTY ASSISTANT SECRETARY FOR ENVIRONMENTAL MANAGEMENT, U.S. DEPARTMENT OF ENERGY, WASHINGTON, DC

Admiral GUIMOND. Thank you very much, Mr. Chairman and members of the Subcommittee.

I appreciate the opportunity to appear before you to talk about the Department of Energy's Environmental Management Program. I have a longer written statement that I will submit for the record, and I'll just summarize my points here.

I'm here to present our fiscal year 1997 non-defense budget for the Department of Energy's Office of Environmental Management, or it is frequently called the clean-up program of the Department of Energy. Now this is really a misnomer because much of our highest priority tasks involve safety and security of more than 24 metric tons of weapons-grade plutonium and thousands of tons of spent nuclear fuel. We believe that perhaps a name such as Nuclear Materials Safety and Security Program may be apt more frequently than Environmental Management.

We have aggressively moved our program forward, and I'm pleased to report that we are well on our way down the road to reduce risks and finish cleanup. For the second straight year the Department is requesting less in budget authority for the entire program than the previous year. For fiscal year 1997 we are requesting $5.8 billion in total new budget authority, an overall reduction of 3.4 percent from 1996.

However, our budget request for the energy supply, research and development appropriation of $651 million is a nine percent increase over the comparable amount in fiscal year 1996, and this money will go to a program that is aggressively focused on obtaining measurable results.

While we are getting results, I need to add a note of caution. To continue making progress and not merely to maintain the status quo, Congress must enact the President's budget. We truly need a predictable budget across our sites to be able to maintain this progress.

We are now getting results that reduce urgent risks. I'm happy to report that we have recently started operations at the largest waste treatment plant in the world at our Savannah River site. As we speak it's converting unsafe liquid high-level nuclear waste, and about 33 million gallons of it, into solid glass form ready for disposal. In fact, just two days ago we poured our first radioactive log into a stainless steel canister ready for storage.

At West Valley Demonstration Plant in New York we have completed the construction of a similar vitrification facility, and we are now making final preparations for radioactive operations which we expect to begin in June of this year.

We are also getting results by cutting bureaucratic paper shuffling. We are contributing to a leaner Federal Government by operating on an fiscal year 1996 budget that is less than 1995 given a comparable scope of work. Over the last year we have reduced support services by over 50 percent and headquarters funding by

36 percent, and we've cut our contractor workforce by over 20,000. We have eliminated duplicative oversight of our field operations by eliminating 156 DOE orders.

We are also getting results by spending more on cleanup and less on study. We've passed the point where most of our effort went to legally mandated assessments and studies. We are now in the business of shoveling dirt instead of paper. Over the last two years our funding for direct cleanup has gone from under one-half to over two-thirds of the total environmental restoration budget. Funding for assessment has been cut in half during the same period.

We completed 75 large-scale environmental cleanups in 1995, which is a 135 percent increase over 1994. We now have a total of 194 finished and 511 to go.

In fiscal year 1995 we completed remediation of six former industrial processing sites under the Formerly Utilized Sites Remedial Action Program, or FUSRAP, in vicinity properties and two sites where uranium mining and milling once occurred. Remediation of 16 out of 24 uranium mill tailings and remedial action processing sites is now completed, and remediation was completed at 57 public and private properties that were contaminated with uranium mill tailings.

In addition, three other small sites were completed. The Uranium Mill Tailings Surface Program was reduced from $66 million in fiscal year 1996 to $43 million in 1997 in accordance with its planned completion in fiscal year 1998.

The Department is supporting legislation to extend the current authorization which expires at the end of 1996 through fiscal year 1998 so the program can be completed. The increase in the FUSRAP cleanup activities from $74 million in fiscal year 1996 to $83 million in fiscal year 1997 is part of an environmental restoration strategy to accelerate remediation completions at small sites and complete the FUSRAP program by 2016.

At our Oak Ridge site in Tennessee we have eliminated 90 percent of the low-level radioactive waste generated per year from the radioactive material management area. Shrinking this work area has resulted in less-contaminated protective clothing and saves over a million per year in waste at disposal sites.

We are also getting results from the new way we do business. Our contract reforms have been vital in making the transition from a cold war production system to the new mission. Today imperatives are efficiency, progress and accountability, not production at any cost. Performance is measured through cost control, safety and real on-the-ground progress.

We are now completing and saving our for-profit contracts on major sites. Contractors have pledged savings of approximately $2 billion in the first two competitively-awarded procurements alone, the Idaho National Engineering Laboratory and the Rocky Flats Environmental Technology Site.

We are also making significant progress on increasing privatization. Including in this year's budget request is significant funding for the largest privatization operation ever undertaken, the Hanford Tank Remediation. As you know, we have already released a Request For Proposal for this bold, new initiative and have received substantial interest from private industry. We intend to go forward with the award of this contact after Congress has given us some indication of our support for fiscal year 1996.

We believe that through working closer with citizens groups, unions and the various communities that we have, that we've done a lot to make significant progress and to reduce the overall costs. For example, at our Fernald Activity we are expecting to get a savings of about $1 billion in costs over the life of the project.

In conclusion, we're proud of the progress the Environmental Management Program has made over the last three years. We have begun to change the way in which this enormous infrastructure is operated. We have realigned work forces, modified multi-year and multi-billion dollar contracts and imposed strict discipline on financial procedures. We recognize the imperatives of maximizing efficiency in cutting costs to the bone.

It is critical, however, to recognize that although we can economize and increase efficiency, there is a point beyond which further reductions in our budget will not only mean increased risks but also higher long-term costs.

The results from the changes we have made are beginning to arrive and will, with a stable budget, continue to grow for the next several years. I ask you for your full support for our budget request to continue our progress in this vital program.

Thank you very much.

Chairman ROHRABACHER. Thank you very much, Admiral.

[The prepared statement of Real Admiral Guimond follows:]

Statement of Richard J. Guimond

Assistant Surgeon General, USPHS
Principal Deputy Assistant Secretary for Environmental Management
Department of Energy

before the
Subcommittee on Energy and Environment
of the
Committee on Science
U.S. House of Representatives

May 1, 1996

Statement of Richard J. Guimond
Assistant Surgeon General, USPHS
Principal Deputy Assistant Secretary for Environmental Management
Department of Energy

Mr. Chairman, and Members of the Subcommittee, I appreciate this opportunity to appear before you to discuss the Department of Energy's Environmental Management (EM) program and its Fiscal Year (FY) 1997 budget request. Last year, I appeared before you to say that we had "turned the corner" on addressing the legacy left behind by fifty years of nuclear weapons production. This year I am pleased to report real results -- not only results "on the ground" -- but also in a new way of doing business. Clearly, we still have a long way to go; but, we are on our way.

Today I would like to:

- Describe the Environmental Management program and present some of our significant accomplishments from the past few years.
- Present an analysis of the budget requests for each program area, explaining the major activities and accomplishments for each program.
- Review our commitments for our Fiscal Year 1997 budget, and outline the strategy and vision for the future of this program and its mission.

INTRODUCTION

For the second straight year, in Fiscal Year 1997, the Department is submitting an overall budget for the Environmental Management program that represents a reduction from the previous year given a comparable scope of work. Under our proposed Fiscal Year 1997 budget, we will continue to contribute to a leaner federal government by doing more work with less money. We have succeeded in driving down the costs of our program while increasing our productivity. We implemented enormous changes in this program and the results of those changes are well represented in this budget. Our Environmental Management Fiscal Year 1997 budget request under the Energy Supply Research and Development appropriation aggressively focuses on obtaining measurable results, minimizing risks to workers, the public, and the environment, and effectively prioritizes and sequences work covered by Federal and State agreements to incorporate relative risk.

The Department's Fiscal Year 1997 budget request for Non-Defense Environmental Management of $651.4 million is a $53.5 million (9 percent) increase over the comparable amount in Fiscal Year 1996. Of this amount, approximately 55 percent is for Environmental Restoration, 30 percent is for Waste Management, 14 percent is for Nuclear Material and Facility

Stabilization, and 1 percent for Site Operations.

BACKGROUND ON THE ENVIRONMENTAL MANAGEMENT PROGRAM

The “Environmental Management” program is often referred to as the “cleanup program.” This terminology unfortunately may lead to a misunderstanding about our real responsibilities. Some of the highest priority tasks have little to do with what one traditionally thinks of as “cleanup.” For example, we are responsible for the safeguard and security as well as the safety of more than 20 metric tons of weapons-usable plutonium. Moreover, unlike many hazardous chemical wastes, radioactive waste cannot simply be broken down into constituents elements; it requires isolation from the environment through treatment and/or disposal while it decays. We are undertaking significant disposal operations to deal with the waste permanently, although long-term land-use control may continue to be required after disposal. In other cases it is neither technically possible nor prudent from a safety or financial perspective to attempt to eliminate or remove the waste and contamination. In these cases, it may be more appropriate to stabilize and monitor the waste where it is. Hence, the "nuclear materials safety and stewardship" program may be an apt description for much of our program.

It is difficult to communicate the size and variety of the tasks being addressed by the Environmental Management program. The industrial infrastructure used for producing and maintaining our nation’s nuclear weapons deterrent was massive. Factories, laboratories, and thousands of square miles of land were devoted to the successful enterprise of producing and testing nuclear weapons in support of national security.

A map of the facilities for which the Environmental Management program is now responsible includes the basic facilities used for weapons material production -- the Savannah River Site, the Hanford Site, the Idaho National Engineering Laboratory, the Rocky Flats Environmental Technology Site -- as well as numerous smaller facilities: Tonawanda, Fernald and old uranium mill tailings sites. Like most industrial efforts, the nuclear weapons complex generated waste. The problems posed by the weapons complex, however, are unique as they include unprecedented volumes of contaminated soil and water, radiological hazards from special nuclear materials, and a vast number of contaminated structures ranging from chemical plants to evaporation ponds.

Last year, we estimated the cost for stabilizing and cleaning up these facilities to be approximately $200 billion with a range of $170 to $350 billion, depending on the expected future land use and project efficiency. We are now completing a more detailed update of that estimate. This effort should provide a much better estimate because of improved life-cycle cost analysis capabilities in field offices. We are using these results to help drive down the life-cycle costs of the program. Regardless of the specific details, it is clear that it is the largest environmental stewardship program in the world. It is also clear that this challenge warrants serious attention to the technologies and business methods necessary to ensure that the job is done in the smartest and most cost-effective manner possible.

As a result of the abrupt cessation of new nuclear weapons production operations in the late 1980's, we not only have inherited a legacy of thousands of contaminated areas and buildings, and huge waste volumes, but we also have responsibility for large amounts of nuclear materials still "in the pipeline" of their production processes. For example, the program stores approximately 25 metric tons of plutonium, which pose extraordinary safety and security obligations. This quantity of plutonium is sufficient to fabricate nuclear weapons, so the security as well as the safety of this material is of paramount importance. Moreover, plutonium can spontaneously ignite in contact with moist air in certain circumstances, thereby requiring careful attention to handling and storage safety. We believe that our primary job is to address these most immediate, urgent risks to human health and the environment as well as manage the long-term contamination and safety threats, reducing the long-term mortgage passed on to others.

To summarize, the Environmental Management program is responsible for managing such diverse risks and issues such as:

- hundreds of large, underground high-level radioactive waste tanks, some of which have leaked, and some of which may pose a danger of an explosion unless properly managed;

- the need for security to prevent theft or diversion of nuclear weapons material (e.g., plutonium and highly enriched uranium) and sabotage of nuclear facilities;

- vast quantities of surplus nuclear weapons material which need to be stabilized since they pose a risk to the public, our workers and the environment in their current state;

- thousands of metric tons of highly radioactive spent nuclear fuel, some corroding in various types of storage;

- thousands of radioactively contaminated buildings that must be deactivated and eventually decontaminated;

- over one half million cubic meters of solid and liquid wastes safely stored awaiting treatment and/or disposal.

- contaminated drinking water, soils, and surface water;

- the potential for worker exposure to radiation and chemicals; and

- the need to safely transport large amounts of hazardous materials, on-site or between sites.

We also are the "landlord" of numerous large sites around the country, some of them are essentially small cities. This means that roads, electrical power, food services for employees, fire and emergency services -- everything that it takes to safely and efficiently manage these sites -- are our responsibility.

Establishing priorities among such diverse risks and complex requirements has proven to be a major managerial and technical challenge. We are proud of our accomplishments in this area. In budget terms, funding is required simply to prevent risks from emerging or increasing. Additional funding is required to further eliminate the source of potential risks -- the untreated wastes and nuclear materials. This work does not occur in a regulatory vacuum. As a federal entity, we have significant legal and regulatory obligations that drive our funding requirements. In addition to federal and state environmental and safety laws and regulations, this program operates within a complicated framework of other commitments and expectations, which include the following:

- Defense Nuclear Facilities Safety Board Recommendations;
- Worker safety and health protection expectations derived from nuclear industry practices and Departmental orders;
- Short- and long-term technology development needs;
- International Atomic Energy Agency nuclear nonproliferation safeguards requirements;
- Compliance agreements or court orders; and
- Worker and community transition needs (e.g., training and land reuse).

Finding cost-effective ways to address these issues now rather than deferring solutions to later generations has been the goal of Congress and this program. In fact, this notion of "responsible stewardship" was one of the primary issues raised by the National Academy of Sciences (NAS) in their recent review of the Environmental Management program. As part of our efforts to ensure that we are moving in the right direction, we requested the NAS to review the overall Environmental Management program and to make recommendations for improvement. We welcome their findings and recommendations, recently released in the report, Improving the Environment. The NAS focused on priority setting, science and technology issues, and regulatory measures. They concluded that a number of our program's initiatives "are rapidly introducing change into a system that was established during the Cold War" and that our "principles and general direction are encouraging." Despite the strides we have made, the NAS points out -- and we acknowledge -- areas that need improvement. Shortly, we will provide a formal response to the NAS report, including specific plans to continue improving the management of this program. In addition to the NAS report, the Office of Environmental Management is developing a strategic plan that will be issued in early summer. The strategic plan articulates a mission and vision, defines key management initiatives that the program will pursue in the next year and beyond, and sets forth a process for prioritizing our activities.

PROGRESS IN ACCELERATING CLEANUP AND CUTTING BUREAUCRACY.

The Environmental Management program is committed to, and is increasingly successful in, cost-effectively addressing the environmental and safety problems of the Cold War legacy. This program, however, like many government programs, has had its share of startup problems. Not created from whole cloth but assembled from ongoing duties and budgets of existing Department of Energy programs, the Environmental Management program was initially ill-equipped to handle its tasks. The Environmental Management program has grown since its creation in 1989, largely through the addition of responsibility for newly declared surplus facilities. In 1989, the program assumed full responsibility for Fernald. Soon Hanford, and the Idaho National Engineering Laboratory, were added to the program. In 1993, the Rocky Flats Plant was added. And last year the Mound Site, the Pinellas Plant, and most of the Savannah River Site were added to the overall management responsibilities of the Environmental Management program. Now, the facilities under this program's purview are located in more than a dozen states and cover more than a thousand square miles. In 1993, the Environmental Management program established six strategic goals both to guide our efforts and to serve as yardsticks for measuring progress.

The six goals are:

- to eliminate and manage urgent risks,
- to assure worker safety;
- to improve managerial and financial control;
- to demonstrate tangible results;
- to focus technology development to get results; and
- to establish a stronger partnership through greater public involvement in Departmental decisions.

These goals, that Assistant Secretary Grumbly established when he arrived, have brought tangible results, including shedding inappropriate contracting and operating practices of the past, cutting unnecessary overhead, and getting real results in reducing risks.

Let me report to you some specific examples of meeting goals.

Goal 1 Reduce Urgent Risks

In 1993, we identified three urgent risks that existed at several sites: unstable plutonium, high level waste tanks, and corroded spent nuclear fuel and targets. Each of these was very serious and could have resulted in a catastrophic accident or serious worker injury without focused attention. We have succeeded in eliminating, or taken the initial steps toward elimination of, each of these urgent risks.

- The Savannah River Site Defense Waste Processing Facility -- the largest high level nuclear waste vitrification facility in the world -- started operations on March 12, 1996.

- At the Savannah River Site, we restarted the F-canyon and have stabilized over 36% of the liquid plutonium nitrate solutions, which posed a threat of a criticality or leakage if left unaddressed.

- Also at the Savannah River Site, we restarted the dissolution operation and began dissolving and reprocessing the Mark 31 targets, which are among the most corroded materials in storage.

- We have made substantial progress at Rocky Flats towards stabilizing the unstable plutonium that has been stored in glove boxes since production shut down in 1989. For example, workers have treated approximately 30 kilograms of unstable plutonium metal and oxides in a controlled oxidation furnace, which creates a stable form for interim storage awaiting final disposition. Approximately 30 kilograms remain to be stabilized

- At the Hanford Site in Washington, we have virtually eliminated the risk of a tank explosion from the buildup of flammable gases by installing a state of the art pump, which has exceeded design expectations in its first two years of operation.

- At the Hanford site, the project to remove the deteriorating spent nuclear fuel from the aging K-Basins located near the Columbia River is well underway. The fuel is expected to be removed by the end of 1999 and placed in dry storage in a new Canister Storage Building. The fuel will be conditioned in a form suitable for safe, long term, interim storage.

- Risks from the unknown are almost as great as the risks we do know about from these high-level liquid waste tanks at Hanford. We have made substantial progress toward characterizing the waste in these tanks, which are much less well known than the waste in the tanks at the Savannah River Site. Characterizing the waste is necessary before treating it. Recently, some have criticized the Department for not meeting our characterization goals. What many of our critics fail to understand, however, is that this operation involves cutting-edge science and engineering, and is extremely hazardous in an area with little room for error. I will not sacrifice worker safety to meet artificial quotas. Nonetheless, I am happy to report that after completing our initial learning and technology development experience, we are making much more rapid progress toward the characterization of these tanks.

- Also, at Rocky Flats, we have stabilized approximately 1,900 liters out of 31,000 liters of plutonium solutions. To eliminate the generation of flammable hydrogen and to remove organic compounds which could become flammable, workers have safely repackaged 221 plutonium metal units that were in contact with plastic and are currently in the process of repackaging approximately 1,600 units that are in proximity to plastic.

- At Hanford, we have developed and begun using two technologies to stabilize plutonium materials more quickly and less expensively than with traditional processing methods. We have completed the stabilization of reactive plutonium scrap and incinerator ash.

- We have completed the venting/repackaging of plutonium solids at the Savannah River Site as recommended in the Department's Plutonium Vulnerability Study.

- In compliance with a consent order to the State of Idaho, the second lot of 189 spent fuel units were transferred from inadequate storage facilities to ones meeting current safety standards three months ahead of schedule. And we are well on our way to finishing the transfer of the last lot of spent fuel to proper storage facilities.

- Approximately 2,700 residue drums were vented to eliminate pressure build up and flammable hydrogen accumulation at Rocky Flats.

Vulnerability assessments led by the Office of Environment, Safety and Health identified shortcomings in the way we handle spent fuel, plutonium and hazardous chemicals that could affect the public or worker health or the environment. Overall, 281 of 503 corrective actions identified in the spent fuel report have been completed and 64 of 152 plutonium milestones have been met. We are aggressively developing actions and implementing them to remediate the most urgent risks in the complex.

The Office of Environment, Safety and Health's independent oversight program has also been extremely useful in effectively targeting risk. The comprehensive assessments have provided DOE management with validated, professional appraisals of the site's performance, greatly aiding our ability to target resources to areas of greatest risk to workers, the public, and the environment. The foundation of the new approach is an analytic framework or "template" that clearly articulates the principles and operational elements of sound Environment, Safety and Health management programs. The assessments have identified where we are doing well, where we have to work harder, and also aid in spreading good practices among our sites.

GOAL 2. Emphasize Health and Safety for Workers and the Public

Along with working to protect public health and the environment, protecting the safety of our workers is the highest priority. It would be unacceptable to sacrifice worker health and safety in an effort to protect the public health and the environment for future generations. Our workers face risks unlike any others in this country, and we owe them -- many of whom are also veterans of the Cold War -- a large debt of gratitude. Recognizing the critical role site workers play in our success, we have refocused efforts to ensure a safe and healthful workplace. Three years ago, the rate of lost work days was about 59 per 200,000 person-hours in Environmental Management operations. Today, we have cut that figure by 45 percent. This means not only fewer individuals injured but also a more productive working environment. By focusing managers and training workers, and by discarding duplicative and cumbersome orders, we have been able to get more work done in a safer manner.

The Office of Environmental Management has worked in partnership with the Office of Environment, Safety and Health to provide line program managers with tools to manage safety at our facilities more effectively and at less cost to the taxpayers. Through several joint projects, we have shown that we can do our work better, more safely, and at less cost by integrating safety and health professionals into the planning and execution of our work. We view safety as an asset that allows us to target our most urgent risks, use our limited resources most efficiently, and do our work most effectively.

At Fernald, for example, we avoided nearly $2 million in costs by recognizing and avoiding unnecessary work. This was because safety and health personnel worked side by side with engineers, planners, and other workers to "build in" safety and health concerns during the actual planning of work. In much the same way, we saved $500,000 through early identification and control of hazards at a Hanford plant. We expect this approach to become standard practice throughout the DOE complex and continue to save money while safeguarding worker health and safety.

Some of the Department's rules and orders no longer meet the needs of many of our facilities. These "top down" orders were developed to meet the needs of a stable weapons production system. Deactivation, decontamination, decommissioning, and environmental cleanup, on the other hand, involve hundreds of individual tasks in aging facilities with hazards that are unknown and difficult to predict. A new process -- the "Necessary and Sufficient Process" -- provides a graded approach to safety standards that allows us to tailor the standards to the work and the facilities. In a pilot application of this process at a major Hanford facility, we were able to greatly reduce worker exposure while cutting costs by 50 percent. We hope to use this process to proceed with safe and timely stabilization of facilities at Rocky Flats and other locations throughout the DOE complex.

We are meeting our worker safety goals and we continue to monitor worker health. For example, the Environmental Management program received an award in 1995 from the State of Ohio for two million person hours worked without a lost time accident at Femald. The Savannah River Site recorded 9.5 million person hours without a lost work day due to an on-the-job injury. At Hanford, we completed removal and disposal of highly irradiated reactor fuel spacers from underground silos to reduce exposures to deactivation workers at N area. Recently, however, we were soberly reminded that there is more progress to be made in this area. At the Idaho site, a worker died from a fall from construction scaffolding. These tragedies must motivate us to redouble our efforts to provide a safe and healthful workplace.

GOAL 3: Bring the Program into Managerial and Financial Control

One of the most significant achievements of the Office of Environmental Management is that we have brought more budgetary and bureaucratic discipline to this program. Over the first five years of this program, the budget rose exponentially and soon was over $6 billion, with projections for increases to more than $10 billion per year by 2000. By the time Assistant Secretary Grumbly took this job in 1993, this program was in real need of financial restraint. Assistant Secretary Grumbly's predecessor, Leo Duffy, estimated in December 1992 that one out of three dollars was being wasted. Several months later, the results of a study we commissioned in early 1993 indicated that he was right. The data indicated that our project management costs were substantially higher than both comparable private sector projects and comparable government projects. This situation was unacceptable. Beginning in 1993, we made cost reduction one of the highest priorities.

First, the Administration imposed an overall cap on the growth in the budget for this program. Then we reduced the budget, in real terms. For example, last year's budget request was, in reality, a 4 percent reduction in the budget when viewed against the added responsibilities of managing several of the largest and most complicated former defense nuclear sites. Responsibility for the Savannah River Site, the Mound facility, and the Pinellas Plant were all transferred to our program in 1995. This is clear evidence that the program is committed to doing more with less.

Second, we have integrated information about risks to public health, worker safety, and the environment into the Fiscal Year 1998 budget formulation process. In doing so, we have made an effort to balance risk information with other factors that must be taken into account when setting priorities, making decisions, and allocating resources.

In 1993, Congress was concerned about how the Department was addressing its most pressing problems and establishing priorities among competing environmental management requirements and budgets, and required the Department of Energy to submit a risk report. The Department responded with the draft report, Risks and the Risk Debate: Searching for Common Ground, The First Step, which provides an analysis of the current and proposed risk management activities initiated to reduce risk and fulfill compliance requirements. The report evaluated risks to the health and safety of individual members of the public intended to be addressed by cleanup activities required by compliance agreements. The report also evaluated the health and safety effect of, and the cost associated with, implementing the requirements.

This report provided the first link between budget, compliance agreements and risk activities. Department of Energy field program managers with the relevant expertise categorized the environmental management work. This allowed the Department to understand the spectrum of risks associated with environmental management activities and linked the risks in a qualitative fashion to compliance and budget. After submission of the report in June 1995, with the advice of our external Environmental Management Advisory Board, we began the process of integrating information about risks to public health, worker safety, and the environment into our budget formulation. This process is iterative, and will continue and improve each year as we more fully involve stakeholders and peer reviewers.

Third, we set an immediate goal of a 20 percent increase in measurable productivity; a goal that most Fortune 500 companies would find ambitious. This initial productivity challenge was across-the-board in Fiscal Year 1994. We then set additional productivity goals for individual sites based on their effective use of additional project managers and cost-engineering personnel. We believe we have eliminated most of the "fat" from the program we inherited in 1993.

We also recognized that the skill mix of the workforce for the new mission at many sites was out of balance, and we undertook a significant reduction in unneeded contractor workforces. As this Subcommittee understands, contract employees comprise most of the personnel at our sites. We have had to cut our contractor workforce from a level of approximately 50,000 in 1993 to around 30,000 today. We know that this downsizing has been painful for individuals, families and local economies. We have complied with the letter and the spirit of the requirements of section 3161 of the National Defense Authorization Act for Fiscal Year 1993 to ensure that the contributions of these "veterans of the Cold War" are not forgotten. But times have changed dramatically, and the current and future missions of the Department demand a contractor workforce with the appropriate skills and of the right size. However, we also recognize that we must bring stability to our sites. I want to emphasize again that it is critical that the Congress appropriate all of the President's budget request.

Fourth, to ensure long-term and systemic improvement in productivity, we began a contract reform initiative to provide incentives appropriate for the new mission. Much of the problem, we have learned, was that the contracting methods used in the past were simply inappropriate for the new mission of Environmental Management.

Our contract reform initiative has also been vital to making the transition from a Cold War system to the new missions at many of these sites. Through this initiative, we have fundamentally changed the way contracts are written and awarded for our sites. The tradition of a single prime Management & Operating contractor working at a site for decades, on a cost-plus award fee basis, was dictated by Cold War production imperatives. Today's imperatives are efficiency, progress, and accountability. Our new contracts reward contractor performance. Performance is measured through cost control, safety and real on-the-ground results.

For example, the recently awarded Rocky Flats contract establishes specific results and goals for the contractor, and the contractor will be paid based on the achievement of these results. Fully 85 percent of the contractor's total fee opportunity will be based on performance, while only 15 percent is base fee. The Rocky Flats contract also provides substantial incentives for cost savings by the contractor. Upon validation by the Department of these cost savings, the contractor will receive 35 percent of the cost savings, with half of those savings going directly to employees.

This new approach to contracting will also save money because contracts are being awarded competitively. Within the past two years, the Department has initiated competitions for its for-profit contracts at five of its major sites -- Idaho National Engineering Laboratory, Rocky Flats, the Nevada Test Site, the Savannah River Site, and Hanford. Contractors have pledged savings of approximately two billion dollars in the first two competitively awarded procurements alone -- the Idaho National Engineering Laboratory and the Rocky Flats Environmental Technology Site. In addition, we have changed the way characterization studies and site assessments are handled in the contracts, so that emphasis is placed on doing the actual work, not simply studying the problem. New streamlined study procedures will ensure that problems are properly assessed, without unnecessary research that takes time and costs money.

Much of the recent work we have done to reform contracts and improve efficiency is still in the "predicted" or "expected" stage. However, we already have indications that these changes are working. For example, by relying on off-site, private disposal services for the sanitary waste disposal activities at our Savannah River Site, we saved $34 million because we eliminated the need to construct a new facility. At our Hanford site, we reduced financial, administrative, and information management functions which allowed a savings of approximately $60 million. These are real and significant savings, and are indicative of the expectations we have for the future, and demonstrate the real need we have for change.

In addition to these new site management contracts, we have also made good on our commitment to privatize certain operations where it makes financial and programmatic sense. In the past two months, we have released Requests for Proposal to privatize major waste treatment facilities at the Hanford and Idaho sites. In both of these efforts, the contractor will not be paid until the treated waste is actually delivered from a predetermined mixture of raw waste feed.

We are also, partly at the insistence of the Congress, capitalizing on opportunities to change the way we carry out administrative programs. We have reduced our headquarters expenditures by over 36 percent, or $140 million, in the last year. This is a 50 percent reduction in support services contracts since Fiscal Year 1995. We believe this reduction was absolutely necessary and appropriate. It also reflects a cut in headquarters staffing, which will result in more than a 40 percent reduction in five years. However, we cannot perform the analytical work worthy of this technologically complex and unprecedented program if we reduce these investments in support services any further. We have also streamlined the Environmental Impact Statement process with a goal of reducing process time from 33 months to 15 months, saving an estimated $26 million over five years. The Department received the 1995 Federal Environmental Quality Award for this effort.

Finally, we have undertaken intensive efforts to wring out as much savings as possible at each major site through the use of a management technique known as "work-outs." These involve assembling all of the necessary information and analysis, with the principal decision-makers related to a site, and addressing each of the perceived stumbling blocks to progress, one at a time. The first of these work-outs focused on the Hanford site, and was heralded by all sides -- the State of Washington, the United States Environmental Protection Agency, contractors, site management and Headquarters DOE management - as the breakthrough "St. Louis Blueprint for Action" after the city where it was held. One product from the session was the establishment of a tentative agreement to amend the Hanford Tri-Party Agreement to provide for a single regulator concept. The idea was that only one regulatory agency will be involved in the day-to-day oversight and decision making on specific environmental management decisions.

Another work-out session, for the Savannah River Site, was held in Rock Hill, South Carolina. In this session, the parties agreed to define and implement strategies and tactics to streamline, simplify and improve the effectiveness of the Site's interaction with its regulators. For example, the parties agreed in principle to: a more collaborative approach in establishing and meeting cleanup objectives; adoption of the lead regulator concept for RCRA permitted cleanup; and minimizing duplication between RCRA and CERCLA requirements. Agreement was reached on specific productivity enhancement proposals with savings that could be applied to other site functions. Related cost savings could range from $65 million to $130 million. It is expected that these savings, in part or in whole, would carry over into the out years and depending on the pace of implementation, should yield some savings in Fiscal Year 1996. I am pleased to report that all sides are living up to their commitments in the Rock Hill agreement, resulting in substantial improvements in the operation of the Savannah River Site.

GOAL 4: Demonstrate Results

The Environmental Management program has also proven that it can establish priorities based on risk and get tangible cleanup results for the taxpayers' dollars. We have formally integrated risk-based approaches into our work by mandating that risk prioritization be conducted as part of our site budget guidance. Site managers must now assess the risks at their sites, and develop their budgets accordingly. I would like to call to your attention some of our accomplishments in the last year, both nationally and at specific sites.

Nationally we have:

- Completed 1,225 release sites, making the total of completed sites 2,538, nearly 30 percent of the estimated total number of 8,854 to be remediated. We completed remediation of 25 facilities, making a total of 182 completed facilities, or 20 percent of the 978 facilities that have been accepted into the cleanup program.

- In Fiscal Year 1995, completed remediation of 6 former industrial processing sites under the Formerly Utilized Sites Remedial Action Program (FUSRAP) and vicinity properties (with 22 out of 46 in the program now complete), and 2 sites where uranium mining and milling once occurred. Remediation of 16 out of 24 Uranium Mill Tailings Remedial Action Project (UMTRA) processing sites is now complete. We have also addressed most of the risk from uranium mill tailings around the nearly 5,300 buildings and other vicinity properties where individuals were directly exposed to radon gas and gamma radiation. We have completed the cleanup of 97 percent of those properties. Remediation was also completed at 57 public and private properties contaminated with uranium tailings from these former processing sites. In addition, three other small sites not included in the FUSRAP or UMTRA programs were completed.

- Entered into 29 Consent Orders under the Federal Facility Compliance Act with authorized regulatory agencies for 32 of the 35 sites for which DOE submitted Site Treatment Plans. The cooperative process has resulted in an integrated treatment system across the complex Through this effort, the estimated costs for treatment were reduced by $600 million. In the near term, we will continue to work with the States to finalize remaining Site Treatment Plans and Orders. In the long-term, we plan to continue the cooperative process and build on the progress that has been made between the Department, its regulators, and the public.

- Completed 119 interim actions, 75 larger-scale cleanups and 17 decommissioning actions, resulting in 5 million cubic yards of mill tailings, soil, and rubble stabilized, contained, or otherwise addressed. To put this in perspective, this amount is enough to cover a hole the size of a football field half a mile deep.

- Continued ongoing treatment of wastewater and hazardous waste at Department sites. We have prepared for disposal 270 cubic meters of transuranic waste, treated 3,500 cubic meters of low-level waste, mixed waste, and disposed of 46,000 cubic meters of low-level waste.

- Since its inception, the technology development program has developed a portfolio of 170 new or improved technologies. An ongoing review of 37 of these new technologies revealed that, depending upon the degree of cleanup, at least $15 billion and as much as $20 billion could potentially be saved through the use of just these 37 processes.

At the Oak Ridge Site in Tennessee, we:

- Eliminated 90 percent of the low-level radioactive waste generated per year from the Radioactive Material Management Area. Shrinking the radioactive work area resulted in less contaminated protective clothing and saves over $1 million per year in waste disposal and operations costs. The project cost $300,000 and took five months to implement.

- Treated and discharged 100 million gallons of contaminated water.

- Treated 3.1 million pounds of mixed waste at the Toxic Substances Control Act (TSCA) incinerator at Oak Ridge. Cumulatively, we have treated almost 15 million pounds of waste at the TSCA incinerator.

At the West Valley Demonstration Plant in New York, we:

- Completed construction of the Vitrification Facility, the support NOX Facility, and the Load-In Facility. Preparations for radioactive operations are underway, and the first radioactive canister is scheduled to be processed in June of 1996. Solidification of the high level waste will eliminate the hazards of associated with continued storage of the waste as a liquid.

At the Savannah River Site in South Carolina, we:

- Have begun operations at the Savannah River Site Defense Waste Processing Facility -- the largest high level nuclear waste vitrification facility in the world.

- Reduced radioactive and hazardous waste generation for a savings of $4.6 million in disposal costs.

- Initiated pretreatment of high-level waste at the Savannah River Site by processing approximately 400,000 gallons of high-level waste.

- Approved and started radioactive operations at the In-Tank Precipitation Facility. This system is an essential part of treating the 34 million gallons of liquid high-level radioactive waste at the site. It separates the highly radioactive portions of the waste from the low-level portions. The low-level portion, which constitutes about 90 percent of the volume, is then transferred to the saltstone facility for treatment. The high-level portion is being vitrified.

- Transferred 24,000 gallons of high level waste on February 29, 1995 from the In-Tank Precipitation Facility to the Saltstone Facility.

At the Hanford Site in Washington, we:

- Consolidated special nuclear material for storage and surveillance, providing cost savings of $2.5 million.
- Removed over 56,000 pounds of carbon tetrachloride from the soil above the ground water, and treated 17 million gallons of groundwater in Fiscal Year 1995.
- Recycled the condensate water in the evaporator system at Hanford and reduced the mixed radioactive liquid waste generation by almost 200,000 gallons per year resulting in an annual savings of $3.6 million. The evaporator is expected to continue in operation for the next ten years.
- Saved $40 million in waste treatment and facility maintenance costs by shipping 185,000 gallons of uranium-contaminated nitric acid from Hanford for reuse in Sellafield, England.

At the Rocky Flats Environmental Technology Site in Colorado, we:

- Emptied the last of five contaminated solar ponds in January, which were filled with low-level radioactive process water.
- Completed construction of a new Centralized Waste Storage Facility five months ahead of schedule and $500,000 under budget.
- Completed venting and aspiration of 518 drums of transuranic and mixed transuranic wastes, leaving 700 to be vented.

At the Mound Plant in Ohio, we:

- Decontaminated, decommissioned and completely removed the 18,000 square foot Special Metallurgical Building previously used as a radio chemical laboratory primarily processing plutonium-238.
- Made available approximately 10 percent of the Mound plant land area (29 acres) for sale or title transfer by obtaining U.S. Environmental Protection Agency and Ohio Environmental Protection Agency concurrence that the land met an industrial risk scenario protective of human health and the environment.

At the Fernald Site in Ohio, we:

- Completed all major Environmental Restoration milestones on or ahead of schedule, including several major removal actions (Plant 1 Ore Silos, Fire Training Facility, Plant 7).

- Determined through successful public involvement future land use, site cleanup levels, on and off-site waste disposal locations, and cleanup priorities.

At the Idaho National Engineering Laboratory, we:

- Deactivated 2 key buildings at the Idaho Chemical Processing Plant (ICPP), saving out-year cost of $24.5 million.

- Demonstrated at full scale the Dig Face Characterization system, an innovative new technology that provides quick, non-intrusive characterization of buried waste in support of retrieval operations. This technology allows "on-the-spot" characterization of soil and waste samples since it performs the analysis as it collects it. This system also reduces risks to workers since characterization can be performed remotely and rapidly to identify any potential hazards.

- Began incineration of low-level mixed waste one month ahead of schedule at the Waste Experimental Reduction Facility.

GOAL 5: Focus Technology Development

Innovative technologies offer the promise of significant cost savings. We have focused technology development on five major areas: Mixed Waste Characterization and Treatment; Radioactive Tank Waste Remediation; Contaminant Plume Containment and Remediation; Landfill Stabilization; and Decontamination and Decommissioning. Crosscutting activities that apply to all or some of the focus areas are also conducted: Characterization, Monitoring and Sensors; Efficient Separations and Processing; Robotics; and Technology Integration efforts to enhance the focus areas' ability to achieve accepted, commercially available products. In Fiscal Year 1996, in response to Congressional direction, the Department initiated a science program to bridge fundamental and applied technology development research. This program will continue in Fiscal Year 1997. The Environmental Management's risk management activities are also conducted from the Office of Science and Technology.

We must continue to invest in technology development. For example, DOE landfills contain 3 million cubic meters of radioactive and hazardous buried waste. The landfill caps, once believed to be adequate, have breached and pose a potential threat to people and the environment due to migration of dangerous contaminants to the soil and groundwater. New containment technologies consisting of covers and subsurface barriers to limit water infiltration and spread of contaminants are being developed that will prevent migration of all contaminants for time periods consistent with those of long-lived radionuclides.

Of course, work does not end with developing the technologies. Regulatory and stakeholder acceptance of these technologies is paramount to implementation. Also, the states require rigorous validation processes. Through the Western Governors' Association DOIT (Develop On-site Innovative Technologies) committee, an 18-state Interstate Technology and Regulatory Committee was established with the aim of expediting this process. We realized a major accomplishment in April 1995 when four States (California, New Jersey, Illinois, and Massachusetts) signed a Memorandum of Understanding through which these states agree to share information on technologies and to accept participating states' validation work. This saves time and eliminates duplicative work.

During Fiscal Year 1995, 50 new or improved technologies were demonstrated and 24 were made available for transfer for implementation. 13 new technologies were implemented at waste cleanup sites. For instance, ResonantSonic™ Drilling, an innovative drilling technology that increases drill penetration in difficult geologic media and reduces drilling wastes, was used in Hanford, where it achieved greater than 25 percent cost savings over baseline methods. Also, the Rapid Transuranic Monitoring Laboratory, which provides on-site monitoring of contaminated air and soil, was selected for implementation at the Savannah River Site. This system is capable of processing samples in less than one hour at a cost of approximately $30 per sample compared to $200 to $300 per sample using traditional methods.

GOAL 6: Strengthen Stakeholder Partnerships

Dealing openly and effectively with States, Tribes and the public is not only the right thing to do, it is a requirement of doing business successfully in modern America, and it can reduce cost and improve policy. Hence, we have made this a major element of our operations. Here are few examples of our successes in this area.

- The recent, unprecedented agreement negotiated between the Department of Energy, the State of Idaho, and the Department of the Navy regarding spent fuel and radioactive waste issues at the Idaho National Engineering Laboratory (INEL) has succeeded in positively redefining federal and state relations. The solution covering the receipt, storage and eventual removal of spent fuel from Idaho comprehensively addresses national security, future environmental protection, and public funding concerns. The agreement accelerates the cleanup of INEL and simultaneously continues its vital support of the Navy's nuclear propulsion program. We appreciate the Sense of the Congress resolution supporting this agreement that was included this year in the National Defense Authorization Act.

- Working closely with labor unions at the Mound Plant in Ohio, we recently took a bold step to achieve a mutually supportive approach to cost-cutting. This pathbreaking labor agreement provides a new model for site cleanup and closing issues which will simultaneously increase productivity and workforce stability.

- Stakeholders have been a significant part of the 1996 Baseline Environmental Management Report development process through meetings, workshops, comment periods, newsletters, and national forums.

- We have established a total of 11 Site-Specific Advisory Boards (SSAB) at Fernald, the Grand Junction Projects Office (Monticello, UT board), Idaho National Engineering Laboratory, Hanford, Los Alamos National Laboratory, Nevada Test Site, Oak Ridge, Pantex, Rocky Flats, Sandia National Laboratory, and Savannah River Site. Another SSAB is presently being formed at Paducah and should be in place in the near future.

Citizen participation is an essential part of our decision-making process. Besides enhancing credibility and accountability, it has proven to be economical and effective. For example, after the Fernald Citizens Task Force examined and analyzed conditions at this large industrial site which is comparable in scale to Ford Motor Company's River Rouge plant. They concluded that different parts of the site would be suitable for different future uses. As a result of the collaborative process with the site contractor and the Department, recommendations were made which will save time in completing the cleanup with an estimated one billion dollars in cost savings over the life of the project.

These are only some of the achievements we have realized over the past year. While we can look back at the improvements and solutions, moving forward on our long term goals is of the utmost importance. Accordingly, I will turn now to our plans for the future.

ANALYSIS OF THE OFFICE OF ENVIRONMENTAL MANAGEMENT NON-DEFENSE BUDGET BY PROGRAM AREA

To carry out these diverse tasks and meet our goals, the Environmental Management program for non-defense budget purposes is organized into different program offices. Four primary programmatic entities -- the Offices of Waste Management, Environmental Restoration, Nuclear Material and Facility Stabilization, and Site Operations -- carry out the core missions of the Environmental Management program, with assistance from other Departmental support offices.

The information on the entire Fiscal Year 1997 budget request follows in Table 1. Table 1A shows the programmatic amounts of non-defense funding for Fiscal Year 1997 and the percentage change from Fiscal Year 1996. I will also briefly describe each office and its non-defense budget requests for Fiscal Year 1997.

TABLE 1
ENVIRONMENTAL MANAGEMENT
Appropriations Summary
(in $ Millions)

APPROPRIATION BREAKDOWN	FY 1996	FY 1997	Percent Change
Defense	$5,557.5	$5,409.3	- 2.7%
Energy Supply	596.9	651.4	+9.1%
Use of Uranium D&D Funds	278.8	240.2	- 13.9%
Contribution to the Uranium D&D Fund	- 350.0	- 376.7	+7.6%
Uranium D&D Fund Foreign Fees	0.0	- 45.9	N/A
Subtotal, D&D Fund	- 71.2	- 182.4	+156.2%
TOTAL	**$6,083.2**	**$5,878.3**	**- 3.4%**

The Fiscal Year 1997 request of $5,878 million represents a 3.4 percent reduction from the Fiscal Year 1996 appropriation.

Note: Does not include $182 million being proposed in the government wide general provisions in the *Appendix* volume of the President's Fiscal Year 1997 Budget to provide up-front funding for additional Environmental Management privatization efforts.

TABLE 1A
ENVIRONMENTAL MANAGEMENT
Comparable Non-Defense Program Summary
(in $ Millions)

	FY 1996	FY 1997	Percent Change
Waste Management			
Non-Defense	$173.5	$199 0	+14.7%
Environmental Restoration			
Non-Defense	361.4	358.2	- 0.9%
Nuclear Material and Facility Stabilization			
Non-Defense	78.6	91.4	+16.3%
Site Operations			
Non-Defense	*	2.8	N/A
Use of Prior Year Balances			
Non-Defense	- 19.9	0.0	- 100.0%

* These offices have been established in Fiscal Year 1996 from pre-existing budgets and are proposed as new appropriation accounts for Fiscal Year 1997.

Waste Management
Budget Request: $199,023,000
(30 percent of the total Environmental Management Non-Defense budget)

The Waste Management program's request of $199 million continues ongoing regulatory compliance efforts in Fiscal Year 1997 in line with environmental, safety and health requirements. Priority efforts included in the Fiscal Year 1997 request include continuing high-level waste treatment at the West Valley Demonstration Project in New York to reduce risk associated with the storage of high-level liquid waste and implementing site treatment plans as negotiated through the Federal Facilities Compliance Act.

Funding for the West Valley Demonstration Project increases by roughly $8 million from Fiscal Year 1996. The Project will vitrify about 120 canisters of high level waste in Fiscal Year 1997. This is an increase of 90 canisters over our Fiscal Year 1996 plan. Our goal is to treat half of the West Valley high level waste inventory (660,000 gallons, 300 canisters) by the end of Fiscal Year 1997. Funding for the Oak Ridge Operations Office in Tennessee increases from $11.2 million in Fiscal Year 1996 to $14.4 million in Fiscal Year 1997. This increase largely reflects the resumption of offsite shipment and treatment of waste. Funding for the Oakland Operations Office in California increases from $10.3 million in Fiscal Year 1996 to $13.3 million in Fiscal Year 1997. The increase is driven by operation of Waste Facilities at Berkeley, operation of a new Waste Storage Facility at Stanford, and pursuit of treatment of sodium contaminated waste at the Energy Technology Engineering Center. The Chicago Operations Office is initiating a new Waste Handling Facility the Argonne National Laboratory. The $9 million more in funding this year is also reflects beginning operations of the Sodium Processing Facility at Argonne-West to treat hazardous waste and an increase at Chicago laboratories for disposal of annually generated low-level waste.

TABLE 2
WASTE MANAGEMENT AND CORRECTIVE ACTIVITIES
Funding Summary
(Dollars in Thousands)

Non-Defense Activities	**FY 1996**	**FY 1997**	**Percent Change**
Program Management	2,033	1,150	-43.4%
Facility Operations and Maintenance	45,599	57,887	+26.9%
New Facilities	1,081	1,911	+76.7%
West Valley Demonstration Project	115,389	123,601	+7.0%
National Low-Level Waste	2,865	4,958	+73.0%
Solid Waste	450	3,292	+631.5%
Construction	6,097	6,224	+2.1%
NON-DEFENSE TOTAL, WASTE MANAGEMENT	**173,514**	**199,023**	**+14.7%**

Environmental Restoration
Budget Request: $358,239,000
(55 percent of the total Environmental Management Non-Defense budget)

The Office of Environmental Restoration, the largest percentage of the non-defense Fiscal Year 1997 budget request, continues efforts in Fiscal Year 1997 to identify the sources, nature and extent of contamination to more accurately determine relative risk, scope, and cost of projects. The program will also increase the cost-effectiveness of assessment efforts by establishing objectives before characterization. However, emphasis is placed on doing fewer studies and accomplishing actual cleanup in Fiscal Year 1997.

The Uranium Mill Tailings Remedial Action (UMTRA) Surface program was reduced from $66 million in Fiscal Year 1996 to $43 million Fiscal Year 1997 in accordance with its planned completion in Fiscal Year 1998. The increase in the Formerly Utilized Sites Remedial Action Project (FUSRAP) cleanup activities from $74 million in Fiscal Year 1996 to $83.1 million in Fiscal Year 1997 is part of Environmental Restoration's strategy to accelerate remediation completions at small sites and complete FUSRAP by 2016. Increased decontamination and decommissioning activities at Oak Ridge National Laboratory in Tennessee, from $29.7 million in Fiscal Year 1996 to $36.7 million Fiscal Year 1997, will be used to stabilize and deactivate the Molten Salt Reactor Experiment.

TABLE 3
ENVIRONMENTAL RESTORATION
Funding Summary
(in $ Thousands)

Non-Defense Activities	**FY 1996**	**FY 1997**	**Percent Change**
Facilities and Sites	213,649	224,393	+5.0%
Formerly Utilized Sites Remedial Action Project	73,982	83,079	+12.3%
Uranium Mill Tailings Remedial Action Project	65,946	42,967	-34.8%
Uranium Mill Tailings Groundwater Restoration Project	7,800	7,800	0%
TOTAL, NON-DEFENSE ENVIRONMENTAL RESTORATION	**361,377**	**358,239**	**-0.9%**

Nuclear Material and Facility Stabilization
Budget Request: $91,353,000
(14 percent of the total Environmental Management Non-Defense budget)

The mission of the Office of Nuclear Material and Facility Stabilization is to reduce the high-risk conditions associated with unstable excess nuclear and chemical materials left at former nuclear weapons production facilities and reduce the maintenance costs associated with stabilizing buildings awaiting decontamination or final disposition. This involves the protection of workers and the environment from exposure and contamination, the stabilization of hazardous nuclear and chemical materials, deactivation of facilities to attain the lowest surveillance and maintenance costs, and transfer of facilities to the Office of Environmental Restoration for decontamination and decommissioning. This program area is responsible for some potentially severe risks. unstable plutonium and spent nuclear fuel

The Nuclear Material and Facility Stabilization program's request is $91.4 million Fiscal Year 1997. This request provides for the deactivation and stabilization of surplus facilities and materials, as well as any surveillance and maintenance necessary to protect the public and the environment. These facilities include the Fast Flux Test Facility at Richland, the Rover Facility at Idaho and various surplus buildings at Idaho, Richland and Oak Ridge. Funding for the Oakland Operations Office in California increases from $2.9 million in Fiscal Year 1996 to $16.1 million in Fiscal Year 1997. This increase is due to surveillance and maintenance, and stabilization/deactivation activities associated with the Energy Technology Engineering Center which transfers from the Nuclear Energy program. The surveillance and maintenance budget increase is also needed due to the commencement of efforts to transfer bulk sodium to an offsite user. The Richland Operations Office in Washington has a reduced funding level of $49.3 million in Fiscal Year 1996 to $47.5 million Fiscal Year 1997 because of the completion of the Sodium Storage Facility construction project.

TABLE 4
NUCLEAR MATERIAL and FACILITY STABILIZATION
Funding Summary
(Dollars in Thousands)

Non-Defense Activities	FY 1996	FY 1997	Percent Change
Program Integration	2,846	2,107	-25.9%
Surveillance and Maintenance	43,144	42,673	-1.3%
Stabilization/Deactivation Actions	27,398	38,542	+40.7%
Spent Nuclear Fuel	1,135	1,460	+28.6%
Construction	4,048	6,571	+62.3%
TOTAL, NUCLEAR MATERIAL AND FACILITY STABILIZATION	**78,571**	**91,353**	**+16.3%**

Office of Site Operations
Budget Request: $2,799,000
(1 percent of the total Non-Defense Environmental Management budget)

The Site Operations program supports the cleanup, transition to safe shutdown, and the disposition of the non-defense portion of the Mound site. The Pollution Prevention program is responsible for coordinating and implementing the program in compliance with existing regulatory, Executive Order, and Department requirements, and reporting on the Department's progress in meeting its statutory obligations. The $2.8 million request for Site Operations supports activities at the Mound Plant in Ohio and Pinellas Plant in Florida It also includes $1.6 million for pollution prevention activities within non-defense funded programs and activities. The funding for the Mound and Pinellas Project Office increases from $1.0 million in Fiscal Year 1996 to $1.2 million in Fiscal Year 1997. This increase supports non-defense environmental remediation of contaminated areas within the Semi-Works Cave area at the Mound Plant.

TABLE 5
SITE OPERATIONS
Funding Summary
(Dollars in Thousands)

Non-Defense Activities	FY 1996	FY 1997	Percent Change
Mound and Pinellas Project Office	1,061	1,223	+15%
Site Integration	712	0	-100%
Pollution Prevention	2,567	1,576	+39%
TOTAL, SITE OPERATIONS	**4,340**	**2,799**	**-36%**

CONCLUSION

We are making real progress in the Environmental Management program in addressing some very real health and safety risks and in improving the way we do business. These results are clearly shown by the fact that for two straight years we have reduced our budget undertaking the same, or greater, workload. Nonetheless, given the long-term nature of the program, it is critical to have a vision for the future, beyond a one or two-year budget cycle.

One of the basic problems with the Environmental Management program when it was created was that it was a stepchild of an organization that had very different priorities and missions. Today, the work of the Department with respect to nuclear weapons is much reduced and refocused The Environmental Management program's mission has grown dramatically as we have learned the extent of the challenges we face, and as public awareness and concern about safety and health has heightened.

The environmental, safety and health problems in the nuclear weapons complex are often larger and typically more intractable than those of most conventional commercial cleanup programs. In many cases, no effective technologies exist to clean up hazardous and nuclear waste sites. Even where technology exists, we often lack agreement on "how clean is clean?" And the fiscal reality is that there will be less money for activities we have performed in the past. It is critical to recognize that although we can economize and increase efficiency, there is a point beyond which further reductions in our budget mean less work, and increase the risks to public health, workers, and the environment.

Despite these challenges, we are moving forward. The program inherited business practices, managerial structures, and contractual systems not designed for effective completion of the type of work to be done. We have changed this and are creating a strategy to meet our goals. Assistant Secretary Grumbly's vision for the program is one that will blend business practices that are proper for the type of work that we do with the accountability and responsibility that are required of us as public servants. Our long-term strategy involves focusing on stabilizing the problems at our sites using risk based priorities, while simultaneously making the necessary investments in developing new technologies to grapple with certain intractable problems in a more cost-effective manner. We have substantially increased our investment in science and technology with the new Science Initiative and the new Spent Fuel Technology Development Program, which is centered at the Savannah River site and Idaho. Having made these investments, we are confident that the work we do in stabilizing the sites will buy us the time to implement these new more cost-effective remedial technologies in the future. We are confident that the same ingenuity that fought the Cold War will enable us to successfully seek solutions to the current challenges we face. We ask you for your full support for our budget request to continue our progress in this vital program.

Chairman ROHRABACHER. Ms. Steinhardt.

STATEMENT OF MS. BERNICE STEINHARDT, ASSOCIATE DIRECTOR, ENERGY, RESOURCES, AND SCIENCE ISSUES, RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION, U.S. GENERAL ACCOUNTING OFFICE, WASHINGTON, DC

Ms. STEINHARDT. Good morning, Mr. Chairman and members of the Committee.

With your permission I would like to enter our written statement and our report into the hearing record, and I will limit my oral remarks.

Chairman ROHRABACHER. Without objection, and thank you.

Ms. STEINHARDT. Thank you. Thank you also for the chance to be here today and to talk about one part of DOE's non-defense cleanup effort, the Uranium Mill Tailings Remedial Action Program, the UMTRA Program.

In my testimony this morning I want to give you an overview of the status of the cleanup program, how much it has cost thus far, and I also want to lay out some factors that could affect the Federal Government's costs down the road.

This year the authority for UMTRA is expiring, and I would like to share also with you some of our thoughts on issues that the Congress may want to consider in any reauthorization effort.

In our written statement we have some background information about DOE's cleanup effort overall. Here though, the only point I would like to make is that in sharp contrast to the rest of the cleanup effort the UMTRA Program is actually nearing completion, at least in part.

As Admiral Guimond indicated in his statement, the cleanup of surface contamination at UMTRA sites has been completed at about two-thirds of the sites, and work is underway at most of the rest. Nevertheless, since the program began about 17 years ago, it has grown both in its size and cost.

After the program was underway and DOE developed its original time and cost estimates, the Department found it had to respond to a number of unforeseen conditions, new EPA groundwater standards, new hazardous waste transportation requirements, state and local government concerns about public safety and also unexpected discovery of additional tailings both at the processing sites and at vicinity properties.

DOE now expects to be finished with the surface cleanup effort, which involves about two dozen sites and over 5,000 vicinity properties, in 1998 at a cost of $2.3 billion in current, that is 1995 dollars. If this forecast holds, it will have taken nearly eight years longer and cost over $600 million more than DOE originally expected, a 37 percent cost growth.

This won't be the full extent of the necessary cleanup though, because besides the ground level or surface cleanup that is required, DOE still has to deal with the contamination of groundwater around the sites. It began to address this issues several years ago, and it spent close to $17 million on it, largely for planning and characterization efforts; but actual cleanup of groundwater hasn't started at any location.

Looking ahead DOE is now proposing a cost-conscious strategy, a kind of least-cost strategy that would require active remediation at only two sites and would rely on a passive cleanup approach or no action at all at the remaining sites.

If DOE can reach agreement on this approach with the affected states and tribes, it may be able to hold additional groundwater cleanup costs to somewhere between $130- and roughly $200 million. Otherwise, costs could be higher.

In fact, another element of uncertainty here in the groundwater cleanup costs has to do with the technical assumptions that underlie the cost estimates, and if these turn out to be invalid, the costs could be higher, and in fact DOE has already identified and included in its total project costs five sites where it believes that it may have to implement more expensive alternatives than the ones it initially proposed.

It's also unclear now how cleanup will proceed if the States are unwilling or unable to pay their share of the cleanup costs. Under the Uranium Mill Tailings Act, States are supposed to contribute 10 percent of the costs for remedial actions, but several States reportedly may not have the funding for groundwater cleanup. If that's the case and the States don't pay their share, then DOE believes that it's prohibited from cleaning up the contamination at all.

So this is one area where we think the Congress may want to have some say, that is whether and under what circumstances DOE can complete the cleanup if States don't provide financial support.

Another area of uncertainty surrounding future costs has to do with the disposal of tailings that are unearthed in the future in the Grand Junction, Colorado area. DOE has already cleaned up the mill processing site and there are also more than 4,000 properties that have been cleaned up around the Grand Junction area, but there are still in place about a million cubic yards of tailings that were used in burying utility lines and constructing roads in the area.

When these roadways and other like things are dug up for repairs in the future, there won't be any place to easily and safely dispose of the tailings unless the DOE-built disposal cell, the ultimate repository, is left open. Currently the Act requires DOE to close the cell once the surface cleanup is complete, and that is actually rapidly approaching.

DOE and the State of Colorado have developed a plan to keep the cell open for another 20 to 25 years or until it is full, but this would entail an annual operating cost of about $200,000 or potentially several million dollars in total. Since this plan would require statutory authority as well as additional funding to implement, Congress may want to address this issue.

And, lastly, another area of uncertainty surrounding the government's future costs has to do with the long-term care of those sites that are being cleaned up by private owners and operators under Title II of the Act. These are the sites that were active at the time the Tailings Act was passed, and these have been the responsibility of private owners and operators.

Eventually DOE will be responsible for maintaining and surveying all of the mill sites that are cleaned up under the Act, both by the government and private owners, but the Act envisions that before owners and operators turn over custody of their sites to DOE, that they would pay this one-time charge that would yield interest in an amount sufficient to cover the annual custodial costs over the life of this period. The point here was to make sure that the owner/operator and not the Federal Government would bear the long-term costs.

The amount of this one-time charge though was last developed by the Nuclear Regulatory Commission in 1980. Since then, however, obviously DOE has had a number of years of actual experience with it's own program, and on the basis of that experience it believes that the actual monitoring costs are considerably more than what NRC has estimated and that some amount of ongoing maintenance, which isn't included at all in the NRC estimate, will be needed.

So in light of the potential shortfall in custodial funds, which could be considerable, our report recommended that NRC and the Department of Energy work together to update the charge and determine if in fact routine maintenance will be required at every site. Our understanding is that DOE and NRC have in fact begun those discussions, and NRC is taking another look at the basis for its charge.

So with that overview, I will end my statement and look forward to any questions. Thanks very much.

Chairman ROHRABACHER. Thank you, Ms. Steinhardt.

[The prepared statement and attachment of Ms. Steinhardt follow:]

United States General Accounting Office

GAO

Testimony

Before the Subcommittee on Energy and Environment, Committee on Science, House of Representatives

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DOE CLEANUP

Status and Future Costs of Uranium Mill Tailings Program

Statement of Bernice Steinhardt,
Associate Director, Energy, Resources,
and Science Issues, Resources, Community,
and Economic Development Division

G A O
75 years
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GAO/T-RCED-96-167

Mr. Chairman and Members of the Subcommittee:

We are pleased to participate in this hearing on the Department of Energy's (DOE) fiscal year 1997 budget. Our testimony focuses on one part of DOE's cleanup efforts: the cleanup of contamination that resulted from decades of processing uranium ore as part of the nation's nuclear weapons and energy program. Under the Uranium Mill Tailings Radiation Control Act of 1978, DOE was required to clean up inactive sites, while private owners/operators were required to clean up those sites that were active at the time the law was passed.

Although the act directed that the cleanup of surface contamination be completed by March 1990, the Congress subsequently extended the deadline twice. DOE's authority now expires in September 1996, and DOE is seeking to extend the deadline to 1998. In anticipation of congressional deliberations on reauthorizing the program, we recently examined (1) the status and cost of DOE's cleanup program and (2) factors that could affect the federal government's costs in the future.[1] We are pleased to report our findings to you today, but to provide a context for our discussion, we would like first to present an overview of the larger effort to clean up the weapons complex and some recent observations about the cleanup program's costs.

The huge cost of cleaning up the weapons complex has been a matter of growing concern. DOE is responsible for environmental restoration, waste management, and facility transition and management at 15 major contaminated facilities and more than 100 small facilities in 34 states and territories. These facilities encompass a wide range of environmental problems, including more than 7,000 locations where radioactive or hazardous materials were released into the environment, as well as almost 200 tanks that contain high-level radioactive waste from nuclear weapons production, some of which have leaked or could explode. Over the last several years, the total estimated cost of the DOE's cleanup has gone from roughly $100 billion in 1988 to a current figure ranging from $230 billion to a high of $350 billion.[2]

Mr. Chairman, over the past several years we have frequently reported on many issues that have affected and will affect the cost of the cleanup. One of these is the need for a national risk-based strategy under which DOE and its regulators can negotiate realistic agreements and milestones under increasingly restrictive budgets. We have also highlighted the need for DOE to more effectively address the complex technical problems it faces in cleaning up its most vexing problems, such as the high-level tank wastes at Hanford, as well as the need for more effective contractor management.[3]

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[1] Uranium Mill Tailings: Cleanup Continues, but Future Costs Are Uncertain (GAO/RCED-96-37, Dec. 15, 1995).

[2] These amounts are in 1995 dollars, but have not been discounted. All other amounts have been converted to discounted 1995 dollars.

Cleaning up these sites is an enormous task that is likely to span multiple generations. To date, only a small portion of DOE's environmental restoration projects have been completely cleaned up. By contrast, DOE's efforts to clean up at least surface contamination under its uranium mill tailings program is near completion; 16 of the 24 sites have already been cleaned up and work is under way or planned at the rest. While groundwater cleanup is still ahead, DOE hopes to adopt a strategy that will minimize its costs. Let me return to our findings on the uranium mill tailings program.

In summary, the cleanup of surface contamination has been completed at two-thirds of the sites and is underway at most of those remaining. However, since the surface cleanup began in 1979, it has grown in both size and cost. If it is completed in 1998, as DOE currently projects, it will have taken nearly 8 years longer than DOE originally expected. It will also have cost $2.3 billion—$621 millon, or 37 percent, more than DOE anticipated. Moreover, total future cleanup costs are still uncertain. DOE estimates that the groundwater cleanup at contaminated properties, which is not subject to the same deadline as the surface cleanup, will be completed in 2014 at a cost of at least $147 million, depending on which cleanup strategies DOE ultimately selects and whether the states pay their share of the costs. Other factors that could affect the federal government's costs include (1) the extent and cost of DOE's role in the future disposal of tailings in the Grand Junction, Colorado, area and (2) whether the charges for the long-term surveillance and maintenance of sites that are supposed to be assessed against owners/operators are sufficient to ensure that the U.S. taxpayer will not bear the burden of the long-term custody costs.

Before discussing these issues in detail, we would like to provide some background information on the program.

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[3] Nuclear Weapons Complex: Establishing a National Risk-Based Strategy for Cleanup (GAO/T-RCED-95-120, Mar 6, 1995), Nuclear Waste: Hanford Tank Waste Program Needs Cost, Schedule, and Management Changes (GAO/RCED-93-99, Mar. 8, 1993), and Department of Energy: National Priorities Needed for Meeting Environmental Agreements (GAO/RCED-95-1, Mar 3, 1995)

Background

During the three decades in which uranium was used in the government's nuclear weapons and energy programs, for every ounce of uranium that was extracted from ore, 99 ounces of waste were produced in the form of mill tailings—a finely ground, sand-like material. By the time the government's need for uranium peaked in the late 1960s, tons of mill tailings had been produced at the processing sites. After fulfilling their government contracts, many companies closed down their uranium mills and left large piles of tailings at the mill sites. Because the tailings were not disposed of properly, they were spread by wind, water, and human intervention, thus contaminating properties beyond the mill sites. In some communities, the tailings were used as building materials for homes, schools, office buildings, and roads because at the time the health risks were not commonly known. The tailings and waste liquids from processing uranium ore also contaminated the groundwater.

Tailings from the ore processing resulted in radioactive contamination at about 50 sites (located mostly in the southwestern United States) and at 5,276 nearby properties. The most hazardous constituent of uranium mill tailings is radium. Radium produces radon, a radioactive gas whose decay products can cause lung cancer. The amount of radon released from a pile of tailings remains constant for about 80,000 years. Tailings also emit gamma radiation, which can increase the incidence of cancer and genetic risks. Other potentially hazardous substances in the tailings include arsenic, molybdenum, and selenium.

DOE's cleanup authority was established by the Uranium Mill Tailings Radiation Control Act of 1978. Title I of the act governs the cleanup of uranium ore processing sites that were already inactive at the time the legislation was passed. These 24 sites are referred to as Title I sites. Under the act, DOE is to clean up the Title I sites, as well as the nearby properties that were contaminated. In doing so, DOE works closely with the affected states and Indian tribes. DOE pays for most of this cleanup, but the affected states contribute 10 percent of the costs for remedial actions.

Title II of the act covers the cleanup of sites that were still active when the act was passed. These 26 sites are referred to as Title II sites. Title II sites are cleaned up mostly at the expense of the private companies that own and operate them. They are then turned over to the federal government for long-term custody. Before a Title II site is turned over to the government, the Nuclear Regulatory Commission (NRC) works with the sites' owners/operators to make sure that sufficient funds will be available to cover the costs of long-term monitoring and maintenance.

The cleanup of surface contamination consists of four key steps: (1) identifying the type and extent of the contamination; (2) obtaining a disposal site; (3) developing an action plan, which describes the cleanup method and specifies the design requirements; and (4) carrying out the cleanup using the selected method. Generally, the primary cleanup method consists of enclosing the tailings in a disposal cell—a containment area that is covered with compacted clay to prevent the release of radon and then topped with rocks or vegetation.

Similarly, the cleanup of groundwater contamination consists of identifying the type and extent of the contamination, developing an action plan, and carrying out the cleanup using the selected method. According to DOE, depending on the type and extent of the contamination, and the possible health risks, the appropriate method may be (1) leaving the groundwater as it is, (2) allowing it to cleanse itself over time (called natural flushing), or (3) using an active cleanup technique such as pumping the water out of the ground and treating it.

Mr. Chairman, we now return to the topics discussed in our report: the status and cost of DOE's surface and groundwater cleanup and the factors that could affect the federal government's costs in the future.

Status and Cost of DOE's Cleanup Project

Since our report was issued on December 15, 1995, DOE has made additional progress in cleaning up and licensing Title I sites. As of April 1996, DOE's surface cleanup was complete at 16 of the 24 Title I sites, under way at 6 additional sites, and on hold at the remaining 2 sites.[4] Of the 16 sites where DOE has completed the cleanup, 4 have been licensed by NRC as meeting the standards of the Environmental Protection Agency (EPA). At 10 of the other 12 sites, DOE is working on obtaining such a license, and the remaining 2 sites do not require licensing because the tailings were relocated to other sites. Additionally, DOE has completed the surface cleanup at about 97 percent of the 5,276 nearby properties that were also contaminated. Although DOE expects to complete the surface cleanup of the Title I sites by the beginning of 1997, it does not expect all of NRC activities to be completed until the end of 1998. As for the cleanup of groundwater at the Title I sites, DOE began this task in 1991 and currently expects to complete it in about 2014.

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[4] The state of North Dakota, in which these two sites are located, has asked DOE to "delist" its sites, or drop them from the program, claiming that the sites present minimal risk to the public and environment and that the state legislature was not likely to appropriate funds for the state's share of the cleanup cost. According to DOE, if the state did not pay its 10-percent share, the Department would not have authority to complete the cleanup. Accordingly, DOE would notify the Congress that it could not complete the planned remedial actions. As of April 1996, DOE had not made a final decision on the North Dakota sites, but it did not include funds for cleaning up these sites in its fiscal year 1997 budget request.

Since its inception in 1979, DOE's project for cleaning up the Title I sites has grown in size and in cost. In 1982, DOE estimated that the cleanups would be completed in 7 years and that only one pile of tailings would need to be relocated. By 1992, however, the Department was estimating that the surface cleanup would be completed in 1998 and that 13 piles of tailings would need to be relocated. The project's expansion was caused by several factors, including

- the development of EPA's new groundwater protection standards;
- the establishment or revision of other federal standards addressing such things as the transport of the tailings and the safety of workers; and
- the unexpected discovery of additional tailings, both at the processing sites and at newly identified, affected properties nearby.

In addition, DOE made changes in its cleanup strategies to respond to state and local concerns. For example, at the Grand Junction, Colorado, site, the county's concern about safety led to the construction of railroad transfer facilities and the use of both rail cars and trucks to transport contaminated materials. The cheaper method of simply trucking the materials would have routed extensive truck traffic through heavily populated areas.

Along with the project's expansion came cost increases. In the early 1980s, DOE estimated that the total cleanup cost—for both the surface and groundwater—would be about $1.7 billion. By November 1995, this estimate had grown to $2.4 billion. DOE spent $2 billion on surface cleanup activities through fiscal year 1994 and expects to spend about $300 million more through 1998.[5]

As for groundwater, DOE has not started any cleanup. By June 1995, the Department had spent about $16.7 million on site characterization and various planning activities. To make the cleanup as cost-effective as it can, DOE is proposing to leave the groundwater as it is at 13 sites, allow the groundwater to cleanse itself over time at another 9 sites, and use an active cleanup method at 2 locations, in Monument Valley and Tuba City, Arizona. The final selection of cleanup strategies depends largely on DOE's reaching agreement with the affected states and tribes. At this point, however, DOE has yet to finalize agreements on any of the groundwater cleanup strategies it is proposing. At the time we issued our report, the cleanups were projected to cost at least another $130 million using the proposed strategies, and perhaps as much as another $202 million. More recently, DOE has indicated that the Department could reduce these costs by shifting some of the larger costs to earlier years; reducing the amounts built into the strategies for contingencies, and using newer, performance-based contracting methods.

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[5] For the surface cleanup costs, fiscal year 1994 data were the most recent available, at the time of our review.

Uncertain Future Costs

Once all of the sites have been cleaned up, the federal government's responsibilities, and the costs associated with them, will continue far into the future. What these future costs will amount to is currently unknown and will depend largely on how three issues are resolved. First, because the effort to clean up the groundwater is in its infancy, its final scope and cost will depend largely on the remediation methods chosen and the financial participation of the affected states. Since the time we issued our report, DOE has reported some progress in developing its groundwater cleanup plans. However, it is still too early to know whether the affected states or tribes will ultimately persuade DOE to implement more costly remedies than those the Department has proposed or whether any of the technical assumptions underlying DOE's proposed strategies will prove to be invalid. If either of these outcomes occurs, DOE may implement more costly cleanup strategies, and thereby increase the final cost of the groundwater cleanup. In its fiscal year 1997 congressional budget request, DOE identified five sites where it believes it may have to implement more expensive alternatives than the ones it initially proposed.

In addition, the final cost of the groundwater cleanup depends on the ability and willingness of the affected states to pay their share of the cleanup costs. According to DOE, several states may not have funding for the groundwater cleanup program. DOE believes that it is prohibited from cleaning up the contamination if the states do not pay their share. Accordingly, as we noted in our report, we believe that the Congress may want to consider whether and under what circumstances DOE can complete the cleanup of the sites if the states do not provide financial support.

Second, DOE may incur further costs to dispose of uranium mill tailings that are unearthed in the future in the Grand Junction, Colorado, area. DOE has already cleaned up the Grand Junction processing site and over 4,000 nearby properties, at a cost of about $700 million. Nevertheless, in the past, about a million cubic yards of tailings were used in burying utility lines and constructing roads in the area and remain today under the utility corridors and road surfaces. In future years, utility and road repairs will likely unearth these tailings, resulting in a potential public health hazard if the tailings are mishandled. In response to this problem, DOE has worked with NRC and Colorado officials to develop a plan for temporarily storing the tailings as they are unearthed and periodically transporting them to a nearby disposal cell—referred to as the Cheney cell, located near the city of Grand Junction—for permanent disposal. Under this plan, the city or county would be responsible for hauling the tailings to the disposal cell, and DOE would be responsible for the cost of placing the tailings in the cell. The plan envisions that a portion of the Cheney disposal cell would remain open, at an annual cost of roughly $200,000. When the cell is full, or after a period of 20 to 25 years, it would be closed. However, DOE does not currently have the authority to implement this plan because the law requires that all disposal cells be closed upon the completion of the surface cleanup. Accordingly, we suggested in our report that the Congress might want to consider whether DOE should be authorized to keep a portion of the Cheney disposal cell open to dispose of tailings that are unearthed in the future in this area.

Finally, DOE's costs for long-term care are still somewhat uncertain. DOE will ultimately be responsible for the long-term custody, that is, the surveillance and maintenance, of both Title I and Title II sites[6], but the Department bears the financial responsibility for these activities only at Title I sites. For Title II sites, the owners/operators are responsible for funding the long-term surveillance and maintenance. Although NRC's minimum one-time charge to site owners/operators is supposed to be sufficient to cover the cost of the long-term custody so that they, not the federal government, bear these costs in full, at the time we issued our December 1995 report, NRC had not reviewed its estimate of basic surveillance costs since 1980, and DOE was estimating that basic monitoring would cost about three times more than NRC had estimated. Since then, NRC and DOE have worked together to determine what level of basic monitoring should occur and how comprehensive the inspection reports should be. However, DOE still maintains that ongoing routine maintenance will be needed at all sites, while NRC's charge does not provide any amount for ongoing maintenance. In light of the consequent potential shortfall in maintenance funds, our report recommended that NRC and DOE work together to update the charge for basic surveillance and determine whether routine maintenance will be required at each site. On the basis of our recommendations, NRC officials agreed to reexamine the charge and determine the need for routine maintenance at each site. They also said that they are working with DOE to clarify the Department's role in determining the funding requirements for long-term custody.

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[6] States have the option of assuming long-term custody of the cleaned-up Title II sites, but DOE does not expect that any states will choose to do so.

Mr. Chairman, this concludes our prepared statement. We will be pleased to answer any questions that you or Members of the Subcommittee may have.

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United States General Accounting Office

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Report to Congressional Committees

December 1995

URANIUM MILL TAILINGS

Cleanup Continues, but Future Costs Are Uncertain

GAO/RCED-96-37

GAO
United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-261528

December 15, 1995

Congressional Recipients

As part of our basic legislative responsibilities, we reviewed the costs and current status of the Department of Energy's (DOE) program for cleaning up uranium mill tailings, conducted under the authority of the Uranium Mill Tailings Radiation Control Act of 1978 (P.L. 95-604). Although the act directed that the cleanup be completed by March 1990, the Congress subsequently extended this deadline twice. Because the current legislative authority expires on September 30, 1996, we are providing this report in anticipation of congressional deliberations on reauthorizing this program. The act made DOE the primary federal agency for managing the program and assigned regulatory responsibilities to the Environmental Protection Agency and Nuclear Regulatory Commission.

This report contains matters for consideration by the Congress concerning DOE's authority under the program. It also contains a recommendation to the Nuclear Regulatory Commission aimed at improving the accuracy of the one-time charge made to owner/operators to ensure that this charge fully covers future costs at their sites.

Please call me on (202) 512-3841 if you or your staff have any questions. Major contributors to this report are listed in appendix I.

Sincerely yours,

Victor S. Rezendes
Director, Energy and
Science Issues

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Executive Summary

Purpose

Decades of processing uranium ore for use in the government's nuclear weapons and energy programs resulted in the accumulation of radioactive wastes at about 50 ore processing sites and about 5,000 nearby properties in various states and on some Indian tribal lands. When the government's need for uranium for defense purposes dwindled in the late 1960s, many of the processing operations ceased, and huge piles of contaminated mill tailings (a sand-like by-product of ore processing) were left in place and spread to nearby properties, posing potential health risks. Accordingly, the Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978, which authorized the Department of Energy (DOE) to clean up contamination at the processing sites. In 1979, DOE developed its Uranium Mill Tailings Remedial Action project. This project has two key components: cleanup of the surface and cleanup of the groundwater.

Because DOE's authority for the surface cleanup will expire at the end of fiscal year 1996, GAO is providing the Congress with information on (1) the status and cost of DOE's surface and groundwater cleanups and (2) factors that could affect the federal government's costs and liabilities in the future.

Background

The Uranium Mill Tailings Radiation Control Act of 1978 authorized the cleanup of the nation's uranium ore processing sites. Title I of the act governs the cleanup of sites that were already inactive at the time the legislation was enacted (referred to in this report as Title I sites); title II covers the cleanup of sites that were still active at that time (referred to as Title II sites). Under the act, DOE is to clean up the Title I sites and nearby properties affected by the contamination, mostly at its expense, but the affected states are to contribute 10 percent of the actual cost of the remedial actions. The Title II sites are to be cleaned up mostly at the expense of the private companies that own and operate them and then turn them over to the federal government or states for long-term custody. Before a Title II site is turned over to federal or state custody, the Nuclear Regulatory Commission (NRC) is responsible for entering into financial arrangements with the owners/operators that provide sufficient funds to cover the costs of necessary long-term monitoring and maintenance at the sites.

After studying the 24 Title I sites that required cleanup, DOE established priorities—high, medium, and low—for cleaning up the sites, based on the severity of their potential risk to public health. DOE used these priorities to help determine the order in which cleanup would begin at the sites.

Results in Brief

DOE anticipates completing the cleanup of both surface and groundwater contamination from uranium mill tailings by about 2014 at a cost of over $2.4 billion.[1] At DOE's 24 Title I sites, surface cleanup is complete at 15 sites, is under way at another 7, and has not yet started at the remaining 2. Approximately 5,000 nearby properties, including homes, schools, and businesses, have also been cleaned up. The cost of the surface cleanup to date totals about $2 billion. The Department anticipates that, if provided a 2-year extension of its authority for the surface cleanup, it can complete its responsibilities in 1998 at an additional cost of about $300 million. DOE is currently seeking reauthorization of its surface cleanup program through fiscal year 1998. Because the Department initially focused on the surface cleanup and because of a delay in the issuance of EPA's final groundwater standards, DOE postponed the start of its groundwater cleanup until 1991. Since then, the Department has primarily studied the sites and developed groundwater cleanup strategies. It has not reached agreement with the affected states and tribes on the cleanup strategies to be used or reaffirmed the states' financial support for the project. However, on the basis of its proposed "least-cost" strategies, DOE estimates that its efforts to clean up the groundwater will cost at least another $147 million.

Various factors could affect the future federal costs and ultimate completion dates of both the surface and groundwater cleanups. Among these factors are whether (1) DOE will keep open a portion of one disposal site to dispose of tailings unearthed during future work on roads and utilities and (2) the affected states will provide their 10-percent share of the groundwater cleanup expenses. Depending on their outcome, these factors could add millions of dollars and years of work to the cleanup effort. Furthermore, the assumptions that underlie NRC's minimum charge to the owners/operators of the Title II sites for long-term surveillance has not been reviewed and updated to reflect the current cost of basic surveillance and does not include the cost of the routine, ongoing maintenance that may be needed at each site.

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[1] All dollars are present-value 1995 dollars, unless otherwise noted.

GAO's Analysis

Status and Cost of Surface and Groundwater Cleanups

After several schedule extensions and increases in the project's costs, DOE currently plans to complete its surface cleanup responsibilities in 1998, at a total cost of about $2.3 billion. For the most part, DOE has completed the surface cleanup at those sites that posed the greatest potential health risk to the public (e.g., sites located near major population centers). At most of the other sites, DOE's cleanup efforts are well under way.

In January 1995, DOE estimated that the total cost of the surface cleanup at the Title I sites will be about $2.3 billion, or $621 million more than it estimated for cleanup in 1982. The increase in the cost of the surface cleanup was caused by unexpected growth in the project's size and complexity. According to DOE officials, this growth came through several avenues. For example, changes in federal requirements resulted in additional work and costs for DOE. To comply with new groundwater standards, in particular, DOE had to change the location and design of many waste disposal cells (containment areas where the tailings are enclosed and stored). Furthermore, as its cleanup work progressed, DOE identified more contamination than its original surveys had projected—more in terms of both the quantity of tailings and the number of nearby properties that needed to be cleaned up.

DOE's groundwater cleanup work began in 1991, and by June 1995 the Department had spent about $16.7 million on planning and developing its strategies for the cleanup. DOE's next step is to consider the views of the affected states and Indian tribes and select the final methods that will be used to clean up the groundwater at each site. If the least-cost strategies that DOE has proposed are adopted, the Department anticipates completing its groundwater cleanup in about 2014, at a minimum cost of about $147 million.

Factors That May Affect Project's Future Costs

Various factors may affect the project's future costs. For example, one factor that could affect these costs is how the project resolves the issue of what to do with the mill tailings in Grand Junction, Colorado, which are now buried under streets and utility corridors, but which may be unearthed during future excavations for repairs. One possible solution is to keep a portion of the Grand Junction site's disposal cell open to deposit any tailings that are unearthed during such repairs. However, according to

DOE, it would need legislative authority to keep a portion of the cell open after its authority for the surface cleanup has expired. Furthermore, keeping a portion of the cell open could result in additional costs of several hundred thousand dollars annually over the next 20 years.

Regarding groundwater cleanup, DOE does not know whether the states will be willing and able to provide their 10-percent share of the cost of the remedial actions. One state has already voiced concern that its legislators may not provide funding for the groundwater cleanup. If the states do not provide their share of these costs, DOE believes it does not have the congressional authority to proceed with the cleanup.

Finally, NRC's minimum charge for long-term surveillance is based on the assumption that the annual cost of surveillance will be $5,300 per site (in 1995 dollars). NRC's charge has not been revised and updated since the basis for the charge was developed in 1980. DOE estimates that the current cost of annual surveillance is $16,000 per site (in 1995 dollars). In addition, DOE estimates that the cost of annual maintenance at each site will be about $5,000 (in 1995 dollars), but NRC's minimum charge was based on the assumption that ongoing maintenance would not be required

Matters for Congressional Consideration

GAO is raising matters for the Congress's consideration concerning (1) the Department of Energy's lack of authority to keep open a portion of the Colorado disposal cell and (2) whether and under what circumstances the Department can complete the cleanups when the states do not contribute their share of the cleanup costs. The complete text of these matters for congressional consideration is found in chapter 3.

Recommendation

To provide a realistic indication of the future costs of long-term monitoring and maintenance, GAO recommends that the Commissioners of the Nuclear Regulatory Commission direct its staff to consult with the Department of Energy to develop an accurate estimate of these costs and what they entail, and use that information to (1) update the minimum one-time charge for basic surveillance and (2) determine whether routine maintenance will be required at each site, and, if so, incorporate the cost for such maintenance into the minimum charge.

Agency Comments

GAO provided copies of a draft of this report to the Department of Energy, Environmental Protection Agency, and Nuclear Regulatory Commission for their review and comment. Officials from all three agencies expressed general agreement with the report's findings.

GAO met with officials of the Department of Energy, including the Office Director, Office of Southwestern Area Programs, who generally agreed with the report's findings and provided technical clarifications that have been incorporated into the report where appropriate. The Environmental Protection Agency's Deputy Director, Federal Guidance, from the Office of Radiation and Indoor Air, also generally agreed with the report's findings and provided technical clarifications that have been incorporated where appropriate.

GAO met with officials of the Nuclear Regulatory Commission, including the Chief of the High-Level Waste and Uranium Recovery Projects Branch, who generally agreed with the report's findings. However, in commenting on the report's recommendations, these officials said that they are not certain that the assumptions NRC used to estimate the one-time charge for basic surveillance are invalid; however, they are reexamining the issue. These officials fully agreed with the report's recommendation to determine if routine maintenance will be required at each site and incorporate any resulting costs into the one-time charge. According to these officials, they have taken a number of steps, described in chapter 3, to ensure that this recommendation will be successfully implemented. Technical clarifications provided by these officials have also been incorporated into the report where appropriate.

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Abbreviations

DOE	Department of Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
NRC	Nuclear Regulatory Commission
UMTRA	Uranium Mill Tailings Remedial Action project

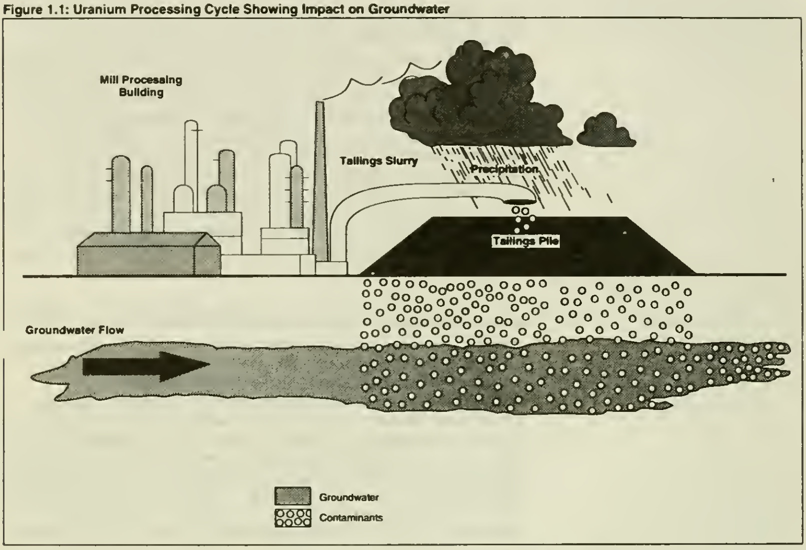
Chapter 1

Introduction

At over 50 sites, mostly in the southwestern United States, widespread contamination of both land and groundwater resulted from uranium ore processing operations that took place from the early 1940s throughout the 1960s. During that period, most of the nation's uranium mining and milling (ore processing) activities were conducted by private companies for the Atomic Energy Commission (the Department of Energy's predecessor). Uranium ore was crushed and processed for use in developing weapons and in the emerging nuclear energy industry. But for every ounce of uranium that was extracted from ore, 99 ounces of waste were produced in the form of mill tailings—a finely ground, sand-like material. By the time the government's need for uranium peaked, tons of mill tailings had been produced at the processing sites. After fulfilling their government contracts, many companies closed down their uranium mills and left large piles of tailings at the mill sites.

The abandoned piles of uranium mill tailings contain radioactive wastes and other hazardous materials that had been used in the uranium extraction process. Despite the potential health risks, some mill operators left the piles of tailings uncovered and exposed to the elements. As a result, the tailings were spread—by wind, water, and human intervention—thus contaminating properties beyond the mill. In some communities, citizens used the tailings as building materials for homes, schools, office buildings, and roads because the health risks were not commonly known. Disposal of the tailings and the contaminated liquids from uranium processing resulted in contamination of the groundwater. In addition, because the piles of tailings were exposed to weather, in some cases the leaching effects of rain and snowmelt also contaminated the groundwater. Figure 1.1 shows how groundwater becomes contaminated.

Figure 1.1: Uranium Processing Cycle Showing Impact on Groundwater



Source Department of Energy and Nuclear Regulatory Commission.

By the late 1960s, radiological research had determined that the abandoned mill sites posed a potential hazard to public health. Exposure to radioactive substances may cause cancer and other diseases, as well as genetic damage. The most hazardous constituent of uranium mill tailings is radium, which is radioactive. Radium produces radon, a radioactive gas whose decay products can cause lung cancer. In effect, the amount of radon released from a pile of tailings remains constant for about 80,000 years. Tailings also emit gamma radiation, which can increase the incidence of cancer and genetic risks. Other potentially hazardous substances in tailings include arsenic, molybdenum, and selenium. The concentrations of these materials found in the tailings vary by site, ranging from 2 to more than 100 times the amounts naturally existing in soil. Concerns about the potential long-term adverse health effects of exposure to uranium mill tailings led to engineering and radiological studies that identified many abandoned uranium mill sites and nearby properties in need of cleanup.

Uranium Mill Tailings Radiation Control Act of 1978 Required Cleanup of Tailings

In November 1978, to provide a comprehensive regulatory scheme for the safe disposal of uranium mill tailings, the Congress passed the Uranium Mill Tailings Radiation Control Act of 1978 (P. L. 95-604). Title I of the act governed the cleanup of mill sites that were already inactive when the legislation was passed, referred to in this report as Title I sites; Title II governed the control and cleanup of milling operations that were still active at that time, referred to in this report as Title II sites. The act made DOE primarily responsible for the cleanup of the Title I sites and the operators/owners of the Title II sites responsible for cleaning up their own sites.

The act assigned responsibilities to three agencies: the Environmental Protection Agency (EPA), the Department of Energy (DOE), and the Nuclear Regulatory Commission (NRC). EPA was directed to establish standards for the cleanup and disposal of contaminated material from both inactive and active uranium processing sites. Under the act, as amended, EPA was to consider factors such as the risk to public health, safety, and the environment, and the environmental and economic costs of applying its standards. In January 1983, EPA issued standards for remedial actions at the Title I sites. Later that same year, EPA issued standards governing the Title II sites. These standards, except those concerning groundwater, were essentially identical to those adopted for the Title I sites.[1] In part, these standards limit the release of radon gas into the environment and require that the disposal method be designed to control radiological hazards "for up to one thousand years, to the extent reasonably achievable, and in any case, for at least two hundred years."

Under the act, DOE was required to clean up all the Title I sites to EPA's standards. The act created a plan of federal and state cooperation in which the federal government, in conjunction with those states where the Title I sites were located, would enter into cooperative agreements for cleaning up the sites. The act directed DOE and the participating state, with the concurrence of NRC, to jointly select the method and perform the cleanup. The states are responsible for 10 percent of the actual cost of remedial actions.

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[1] Both sets of standards were challenged by several parties in the U.S. Circuit Court of Appeals for the Tenth Circuit. The Court upheld all aspects of the standards except the groundwater standards for the Title I sites. In 1987, EPA proposed new groundwater standards for these sites. Final groundwater standards were not issued until January 1995.

NRC, working with EPA, was required to establish regulations governing the control and cleanup of the mill tailings and land at the Title II sites. These sites, generally owned and operated by private companies, are licensed by NRC or by the state in which they are located. NRC was to ensure that its regulations conformed to EPA's general standards and to implement and enforce those standards. Generally, once these sites are cleaned up, they will be turned over to DOE for long-term monitoring and maintenance.

NRC is also responsible for ensuring that before the federal government takes custody of a Title II site,[2] it makes financial arrangements with the owners/operators that are adequate to cover the costs for any necessary long-term monitoring and maintenance. Such arrangements are to ensure that the owners/operators, not the federal government, bear these costs.

DOE Is Managing Cleanup of Title I Sites

Under title I of the act, in 1979 DOE established its Uranium Mill Tailings Remedial Action project (UMTRA) to manage the cleanup and disposal of the tailings at the 22 inactive mill sites designated in the act and at 2 additional sites located in North Dakota that DOE designated.[3] In managing the cleanup of these 24 sites, DOE is responsible for all decisions about the project, for reviewing and supervising work done by its contractors, and for coordinating the cleanup with the affected states, Indian tribes, and local governments.

For each of the sites, DOE assessed the potential health hazard to the public from the tailings and, on the basis of this assessment, established a cleanup priority for the site of either high, medium, or low. DOE used these priorities to help determine the order in which the cleanup would begin at the various sites. However, the priority ranking was not intended to prevent work from being initiated at the lower-priority sites before all the work was completed at the higher-priority sites. Although the cleanup priority was based on the risk to the public, all sites, regardless of this risk, must be cleaned up to the same standards. Figure 1.2 shows the 24 Title I sites, by priority.

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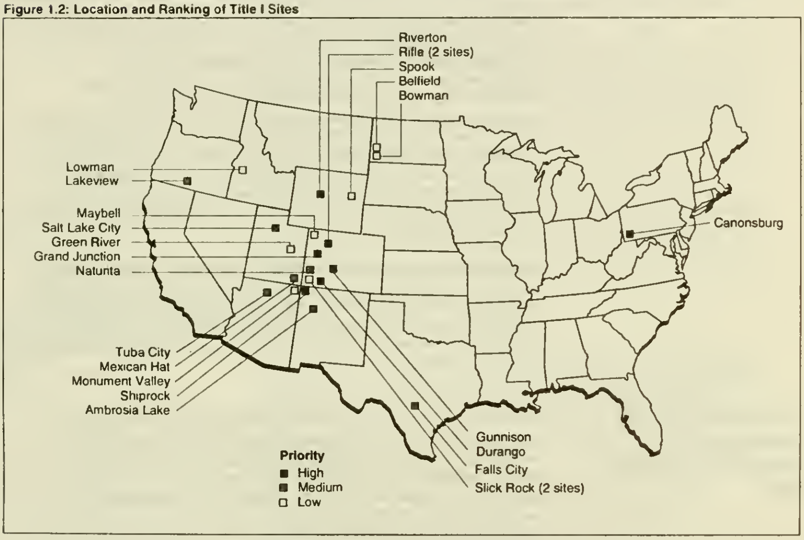
[2] State governments may elect to assume custody of the Title II sites. However, DOE does not expect any states to assume this responsibility.

[3] Unlike most of the other Title I sites, the two North Dakota sites were not uranium mill processing sites. Rather, both were sites at which uraniferous lignite (brown coal containing uranium) was burned in the 1960s. Uranium-rich ash from the kiln process was loaded into rail cars at the sites and transported to uranium mills in Colorado and New Mexico. Ash-contaminated soil remained at the sites.

Figure 1.2: Location and Ranking of Title I Sites



Source: Department of Energy

DOE estimated that over 91 percent of the potential radiological health risks occurred at the nine sites that it had designated as high priority. In turn, the six medium-priority sites represented about 8 percent of the radiological health risks, and the nine low-priority sites posed less than 1 percent of the risks. DOE believed that the greatest health risks were at the 5,000-plus properties in the vicinity of the sites—homes, schools, and other buildings contaminated by tailings and referred to by DOE as "vicinity properties"—because the likelihood of exposure to radon is greatest when radon gas is concentrated in enclosed structures.

Two years after passing the Uranium Mill Tailings Radiation Control Act, the Congress established a different method of setting the cleanup priorities. Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, or Superfund, potentially hazardous waste sites are screened to determine those whose contamination and risk are serious enough to warrant their inclusion on the National Priorities List. This list is composed of sites considered to present the most serious threats to public health and the environment. Once a site has been included on the list, however, its relative risk does not routinely play a part in determining the site's priority for cleanup. Other factors, such as how long a site has been on the list, have influenced the cleanup priority.[4]

Under UMTRA, DOE pays most of the costs of cleaning up the Title I sites, and the owners/operators of the Title II sites generally pay completely for the cleanup of their sites.[5] Under Superfund, hazardous waste generators and transporters, as well as a site's owners/operators, are potentially responsible for either cleaning the site up or reimbursing the government for its cleanup efforts.

Extent of Surface and Groundwater Contamination at Title I Sites

The extent of surface and groundwater contamination varied greatly among the 24 Title I sites. In the aggregate, about 3,900 acres of ground were contaminated with uranium mill tailings and other contaminants, ranging from 21 acres at the Spook, Wyoming, site to 612 acres at the Ambrosia Lake, New Mexico, site (including areas contaminated by windblown material). Furthermore, these 24 Title I sites contained about 39 million cubic yards of surface contaminants, ranging from 58,000 cubic yards at the Belfield, North Dakota, site to over 5.7 million cubic yards at the Falls City, Texas, site.

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[4] Uranium mill tailings sites that are being cleaned up by DOE under Title I are exempt from Superfund.

[5] P L. 102-486 requires DOE to reimburse these owners/operators for the cost of the remedial actions attributable to mill tailings generated as in conjunction with sales to the United States However, the total reimbursement for all owners/operators has a maximum limit.

The groundwater at many Title I sites is also contaminated with radioactive and other elements, such as metals and nitrates. These contaminants can pose risks to human health if the contaminated groundwater is used for drinking water. Although the groundwater is not currently serving as drinking water at any of the Title I sites, groundwater constitutes an important source of drinking water in much of the arid Southwest, where most of these sites are located. For example, according to EPA, nearly half of the drinking water consumed in Arizona and New Mexico and 20-30 percent of the water consumed in Utah, Colorado, Idaho, and Texas is groundwater.

DOE estimates that approximately 4.7 billion gallons of groundwater at the Title I sites is contaminated, but this estimate does not include all sites.[6] Milling operations at the Mexican Hat, Utah, and Ambrosia Lake, New Mexico, sites introduced contaminated water into geological formations that did not previously contain water, but contamination of naturally occurring groundwater has not been observed at these two sites. At 21 of the other sites, however, seepage of contaminated water has affected naturally occurring groundwater. At the site with the highest level of groundwater contamination—Monument Valley, Arizona—an estimated 750 million gallons of groundwater were contaminated. The Lowman, Idaho, site is the only UMTRA site where groundwater contamination is not related to the mill processing operations. Furthermore, the groundwater contamination at that site does not exceed EPA's standards.

What Surface Cleanup Entails

The cleanup of surface contamination consists of four key steps: (1) identifying, or characterizing, the type and extent of contamination; (2) selecting and acquiring a disposal site; (3) developing a remedial action plan, which describes the proposed cleanup method and specifies the requirements for the conceptual design and construction of the disposal cell (a containment area where the tailings are enclosed and stored); and (4) carrying out the selected remedial action. DOE and the affected states work together to select the disposal sites, taking into consideration factors such as the size and density of nearby populations and the existence of flood plains. Thus, the uranium mill site and the disposal site are not always the same. According to DOE, most of the off-site disposal sites are on federally owned land. However, if the selected disposal site is privately owned, the state in which the site is located acquires title to the land (except for sites on Indian lands, which remain with the tribe).

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[6] This estimate is not complete because DOE has found that the level of contamination at some sites is difficult to quantify.

Before acquiring a disposal site, DOE generally completes a site characterization study. If disposal is to be on-site, this study identifies the type and extent of contamination at the site, as well as the geological structure and other features of the disposal site that may affect the placement or design of the disposal cell.[7]

While the site characterization study proceeds, DOE concurrently conducts the environmental assessments required by the National Environmental Policy Act and prepares the remedial action plan. This plan describes the proposed remedial action and lists the requirements for the design and construction of the disposal cell. NRC must concur with the final remedial action plan and with any subsequent changes to it.

Finally, the surface remedial action is performed according to requirements set forth in 40 C.F.R. 192 and DOE's approved remedial action plan. A contractor manages the day-to-day remedial action. Generally, the primary remedial action consists of containing the tailings in a disposal cell. First, the tailings are placed in the containment area, covered with compacted clay to prevent the release of radon, and then topped with rocks or a vegetative covering. When the surface cleanup is completed, DOE prepares a report to certify that the cleanup was completed in accordance with all applicable requirements. NRC reviews and, if it agrees, concurs with the certification of the remedial action. DOE then prepares a long-term surveillance plan. NRC reviews the plan, and if it approves the plan, issues an acceptance letter to DOE, thus bringing the site under a general license for long-term care. Once NRC has licensed a site, the site is transferred into DOE's custody for long-term surveillance and maintenance. Figure 1.3 is a diagram of a disposal cell.

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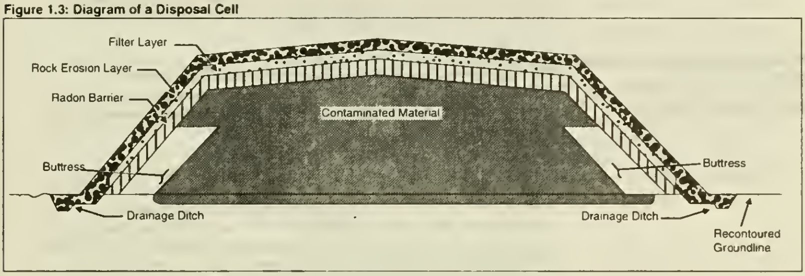
[7] According to DOE, there should be no contamination to characterize at the relocated sites.

Figure 1.3: Diagram of a Disposal Cell



Source Department of Energy

States and Indian Tribes Also Participate in Cleanup Process

The Uranium Mill Tailings Radiation Control Act requires that the affected states participate fully in the cleanup of the Title I sites and that affected Indian tribes be consulted, as appropriate, in the performance of the remedial action on their lands. The involvement of each affected state and tribe is defined through a cooperative agreement with DOE. This agreement establishes the funding, actions involving real estate, and requirements for the technical reviews necessary to perform the remedial action.

Each affected state is responsible for providing 10 percent of the cost of the remedial action for each of its sites and, if necessary, for acquiring title to the processing or disposal site. When the remedial action is complete, the state is required to transfer ownership of the disposal site (if it owns the site) to the federal government. Indian tribes are not responsible for paying any of the costs but participate in selecting disposal sites and proposing remedial actions.

DOE's Responsibilities Do Not End When Cleanup Is Finished

DOE's responsibilities do not end with the disposal of the tailings; the Uranium Mill Tailings Radiation Control Act requires DOE[8] to monitor and maintain the sites to ensure their integrity over the long term. After each Title I site has been cleaned up and NRC has licensed it, the site is transferred to DOE's Long-Term Surveillance and Maintenance Program.

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[8] Or another federal agency designated by the President

DOE will be responsible for long-term surveillance and maintenance not only at the Title I sites but also at most, if not all, of the Title II sites.

Objectives, Scope, and Methodology

The objectives of our review were to provide the Congress with information on (1) the status and cost of DOE's surface and groundwater cleanups and (2) factors that could affect the federal government's costs and liabilities in the future.

To determine the status and cost of the surface cleanup program, we interviewed officials and reviewed documents on budget and status from several DOE offices: the Office of Southwestern Area Programs (in Germantown, Maryland), the Office of Environment/Project Management (in Albuquerque, New Mexico), the Uranium Mill Tailings Remedial Action Project Office (in Albuquerque, New Mexico), and the Grand Junction Projects Office (in Grand Junction, Colorado). We also interviewed several DOE project managers responsible for the sites. In addition, we interviewed numerous DOE contract specialists and reviewed the documents they maintained.

In addition to DOE officials, we also interviewed officials of and reviewed documents from NRC's High-Level Waste and Uranium Recovery Projects Branch and Office of State Programs (in Rockville, Maryland). We also interviewed an official and reviewed documents from EPA's Office of Radiation and Indoor Air. To obtain a state and local perspective, we also interviewed officials from Colorado, New Mexico, and Pennsylvania. We visited sites located in Canonsburg, Pennsylvania; Rifle, Colorado; and Grand Junction, Colorado. We also visited several vicinity properties located near the site in Grand Junction.

To determine the status and cost of the groundwater cleanup activities at the Title I sites, we interviewed officials and reviewed planning and budgetary documents for groundwater cleanup at DOE's Uranium Mill Tailings Remedial Action Project Office. In addition, we interviewed NRC officials from the High Level Waste and Uranium Recovery Projects Branch who have regulatory authority for the groundwater program. We also interviewed officials from EPA's Office of Radiation and Indoor Air.

To identify factors that could affect the federal government's costs and liabilities in the future, we interviewed officials and reviewed documents at DOE's Office of Southwestern Area Programs, Office of Environment/Project Management, Uranium Mill Tailings Remedial Action

Project Office, and Grand Junction Projects Office. (The Grand Junction Projects Office will be responsible for DOE's long-term surveillance and maintenance program as well as for DOE's groundwater program.) We also requested and received letters from DOE's Deputy General Counsel and NRC's General Counsel. In addition, we interviewed officials of NRC's High Level Waste and Uranium Recovery Projects Branch who are responsible for regulating both the Title I and II sites. We also interviewed Colorado state officials about long-term concerns they have about the tailings in Grand Junction, Colorado. Finally, we interviewed representatives of the National Mining Association (formerly the American Mining Congress), a major trade association that represents many owners/operators of the Title II sites.

We conducted our review between January 1995 and November 1995 in accordance with generally accepted government auditing standards. We provided copies of a draft of this report to DOE, NRC, and EPA and discussed the information in the draft report with officials from each agency. Officials from all three agencies generally agreed with the report's findings and provided technical clarifications that we have incorporated as appropriate. Additional details on the agencies' comments are contained in chapter 3.

Chapter 2

UMTRA Project Has Grown in Size and Cost

Since its inception in 1979, the UMTRA project has grown in both size and cost. The surface cleanup at the Title I sites is almost complete, but it took DOE nearly 8 years longer than expected and cost 37 percent more than the agency anticipated. The schedule changes and cost increases resulted from several factors, including unexpected quantities and locations of tailings, changes in federal regulatory requirements, and state and local concerns. As for the cleanup of the groundwater at the Title I sites, efforts have only recently begun. DOE initiated groundwater cleanup at the Title I sites in 1991 and currently estimates completion in about 2014, at a cost of at least $147 million.[1]

Surface Cleanup Is Nearly Complete but Has Taken Longer and Cost More Than Anticipated

DOE is currently seeking reauthorization of the surface cleanup program through fiscal year 1998, or 8 years past the act's original deadline. When it was enacted in 1978, the Uranium Mill Tailings Radiation Control Act directed DOE to complete the cleanup of the Title I sites by March 1990 (7 years after EPA's standards became effective). The deadline for the surface cleanup was later extended through fiscal year 1994, and then still later, through 1996.[2] According to DOE, these extensions were necessary because of growth in the program's size and complexity. The Department currently expects that its surface cleanup will be completed by the beginning of 1997. DOE is working with NRC to expedite the licensing process so that all of the work is completed by the end of 1998.

As of October 1995, the surface cleanup was complete at 15 of the 24 Title I sites, was under way at 7 additional sites, and was being planned at another 2 sites. Of the 15 sites where DOE has completed cleanup, 3 have been licensed by NRC as meeting EPA's standards. Ten of the other 12 sites are working on obtaining an NRC license (e.g., preparing paperwork for submission to NRC or undergoing NRC's review or inspection).[3] Additionally, DOE has completed the surface cleanup at about 97 percent of the 5,276 nearby properties—which DOE terms vicinity properties—included in the program as of October 1995.

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[1] These amounts, as well as all others in this chapter, have been converted to present-value 1995 dollars.

[2] Although DOE, through its 1992 planning process, requested that the program be authorized through fiscal year 1998, the Energy Policy Act of 1992 provided authorization only through 1996.

[3] According to DOE officials, unlike the other sites, the sites at Monument Valley, Arizona, and Riverton, Wyoming, will not be licensed because the tailings were relocated to either a Title I or a Title II site.

In January 1995, DOE estimated that the total cost of the surface cleanup at the Title I sites will be about $2.3 billion,[4] or $621 million (37 percent) more than it estimated in 1982. Through fiscal year 1994, expenditures for the surface cleanup already totaled about $2 billion, and DOE expects to spend another $300 million in completing this cleanup. Of the total projected cost of $2.3 billion, DOE expects to spend about 22 percent cleaning up the vicinity properties and the rest on cleaning up the 24 Title I sites.[5] Through fiscal year 1995, the states will have contributed $99.9 million, and they are expected to spend another $29.6 million through the completion of the program as their share of the cleanup costs.

Table 2.1 summarizes the status and cost of the surface cleanup at the Title I sites and vicinity properties.

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[4] In DOE's accounting system, this amount is reported as $1.47 billion in what DOE terms "escalated" dollars.

[5] While DOE's budget system accounts for the two largest cost components of the cleanup at vicinity properties, it cannot fully itemize all these costs. As a result, according to DOE, the 22 percent of the total project cost that DOE expects to spend for cleaning up these properties is understated to a small extent.

Table 2.1: Status and Cost of Surface Cleanup at Title I Sites, by Location

Site/Location	Actual/ estimated date of completing remedial action	Volume of contaminated materials (in thousands of cubic yards)	Acres of contaminated land	Disposal on site?	Number of vicinity properties	Cleanup costs (in millions of dollars)[a]		
						Expenses through fiscal year 1994	Estimated costs remaining	Total projected costs
High priority								
Durango, Colorado	5/91	2,534	127	No	130	$ 119.11	$ 1.25	$ 120.36
Grand Junction, Colorado	8/94[b]	4,655	114	No	4,381[c]	654.03	92.05	746.07
Gunnison, Colorado	11/95[d]	719	68	No	12	82.38	12.31	94.69
Rifle, Colorado (2 sites)	5/96[d]	4,135	326	No	112	117.62	46.18	163.80
Shiprock, New Mexico	11/86	1,600	130	Yes	15	51.65	0.47	52.12
Canonsburg, Pennsylvania[e]	12/85	226	79	Yes	163	136.79	0.17	136.96
Salt Lake City, Utah	6/89	2,710	128	No	118	204.34	1.15	205.48
Riverton, Wyoming	9/90	1,793	140	No	42	92.07	0.06	92.14
Medium priority								
Tuba City, Arizona	5/90	785	327	Yes	1	53.52	0.77	54.29
Naturita, Colorado	9/97[d]	547	247	No	37	31.40	39.50	70.90
Ambrosia Lake, New Mexico	7/95	3,759	612	Yes	5	54.35	9.03	63.37
Lakeview, Oregon	11/89	926	116	No	8	62.03	0.11	62.14
Falls City, Texas	7/94	5,764	593	Yes	13	68.63	1.91	70.54
Mexican Hat, Utah	2/95	2,810	250	Yes	11	79.99	6.54	86.53
Low priority								
Monument Valley, Arizona	3/94	942	83	No	4	38.30	1.05	39.35
Maybell, Colorado	1/97[d]	3,500	214	Yes	11	23.03	32.93	55.96
Slick Rock, Colorado (2 sites)	12/96[d]	573	139	No	13	23.09	30.95	54.04
Lowman, Idaho	6/92	128	30	Yes	38	28.84	0.02	28.86
Belfield, North Dakota[f]	12/96[d]	58	31	No	7	20.64	20.94	41.58
Bowman, North Dakota[f]	12/96[d]	128	71	Yes	1	1.09	1.56	2.65
Green River, Utah	12/89	382	48	Yes	17	39.25	0.34	39.58
Spook, Wyoming	9/89	315	21	Yes	2	20.33	0.05	20.39

(continued)

						Cleanup costs (in millions of dollars)[a]		
Site/Location	Actual/ estimated date of completing remedial action	Volume of contaminated materials (in thousands of cubic yards)	Acres of contaminated land	Disposal on site?	Number of vicinity properties	Expenses through fiscal year 1994	Estimated costs remaining	Total projected costs
Other								
Edgemont, South Dakota[g]	Not available	Not available	Not available	Not applicable	135	13.43	0	13.43
Total		**38,989**	**3,894**		**5,276**	**2,015.91**	**299.34**	**2,315.23**

[a] All dollars are adjusted to present-value 1995 dollars

[b] Processing site only

[c] Includes 115 vicinity properties that were cleaned up under Grand Junction's remedial action program.

[d] Anticipated completion date

[e] Includes contaminated materials from the vicinity property in the Burrell, Pennsylvania, area

[f] The collection of costs at the Belfield and Bowman sites was not consistent during fiscal years 1980-94, sometimes the costs for both sites were included in the totals for one site, and sometimes the costs were split. However, the combined costs are correct

[g] The UMTRA project is responsible for cleaning up the vicinity properties only—the former uranium mill site in Edgemont is owned and was cleaned up by the Tennessee Valley Authority in the late 1980s

As the table shows, among all of DOE's cleanup sites, the Grand Junction Colorado, location stands out in several respects. Its projected cleanup costs are by far the highest, as would be expected since it had the second greatest volume of contaminated material and the greatest number of vicinity properties that needed cleanup.

The table also shows that the cost of cleaning up the high-priority locations was generally higher than the cost of cleaning up the medium-priority locations, which in turn was higher than the cost of cleaning up the low-priority locations. About 70 percent of the total projected costs will be incurred at the high-priority locations, about 18 percent at the medium-priority locations, and about 12 percent at the low-priority locations. On average, the projected cleanup cost is $179.1 million for a high-priority location, $68 million for a medium-priority location, and $31.4 million for a low-priority location.

In general, at those locations where the tailings were taken off-site for disposal, the costs were greater than they were at the sites where the tailings were kept on-site. Averaged over all locations, the estimated cost of off-site disposal is about $130 million per location, compared with about $55.6 million per location for on-site disposal.

With work completed at 15 of the 24 Title I sites, the bulk of the expenditures for surface cleanup have already been made, as shown in table 2.1. The estimated remaining costs make up only 13 percent of the projected total cost. For the most part, DOE has completed the surface cleanup at those sites that posed the greatest potential health risk to the public (e.g., sites located near major population centers). At most of the other sites, DOE's cleanup efforts are well under way.

Several Factors Increased Cost of DOE's Surface Cleanup

As DOE's surface cleanup at the Title I sites grew in size and complexity, its costs increased. In 1982, DOE estimated that the entire cleanup effort would cost about $1.7 billion, but by 1992, its estimate had risen to $2.3 billion.[6] On the basis of studies it conducted in 1990 and 1992, DOE identified several factors that contributed to the cost increases. Among these factors were the (1) development of EPA's new standards to protect groundwater; (2) establishment or revision of other federal standards addressing such things as the transport of the tailings and the safety of workers; (3) unexpected discovery of additional tailings, both at processing sites and at newly discovered vicinity properties; and (4) changes made in cleanup strategies in response to state and local concerns. DOE has concluded that to varying degrees, each of these factors caused additional work, thus increasing costs.

Compliance With EPA's Groundwater Standards Required Changes in Surface Cleanup Strategies

One of the major factors that DOE identified as driving up the cost of its surface cleanups was EPA's establishment of groundwater standards, which were proposed in 1987 and finalized in January 1995. EPA developed these standards specifically for the UMTRA project.[7] The standards addressed the likely types and levels of contamination associated with all of the sites.[8] The groundwater standards, which were applicable to all the Title I sites, set the maximum levels of contaminants allowed in the groundwater.

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[6] The 1982 estimate assumed that the cleanups would be completed in 7 years and that only one pile of tailings would need to be relocated. However, the 1992 estimate assumed that the surface cleanup would be completed in 1998 and that 13 piles of tailings would need to be relocated. The two estimates, while different in some respects, are the best cost estimates that DOE had available.

[7] According to DOE, until the standards were finalized, it treated the proposed standards as final after 1987, as directed by section 275 of the Atomic Energy Act.

To comply with EPA's new standards, DOE had to ensure that each of its surface cleanup strategies would prevent the uranium and other contaminants in the tailings from entering and contaminating the groundwater underlying the site.[9] DOE had to demonstrate compliance with the revised groundwater standards on the basis of numerical limits. Thus, at six sites, DOE either (1) removed the tailings to an off-site location rather than disposing of them on-site as planned or (2) changed the location of a planned disposal cell. For example, for the site at Naturita, Colorado, DOE plans to relocate the contaminated materials off-site because of their close proximity to the groundwater. DOE estimates that relocating the tailings from that site increased the cleanup cost by about $12 million (in the years of the expenditure). In addition, at five other sites, DOE had to redesign a disposal cell and/or the cell's cover to comply with the new standards. At the Grand Junction, Colorado, site for example, DOE changed the location of the site and redesigned the disposal cell and its cover, resulting in a cost increase of about $48 million between fiscal years 1983 and 1992 (in the years of the expenditure).

Compliance With Other Federal Requirements Also Increased Costs

Changes in other federal agencies' regulations required DOE to undertake additional cleanup activities and also resulted in cost increases. According to DOE, the Department had to comply with federal transportation requirements and health and safety requirements for workers. For example, because the tailings are residual radioactive material (which is classified as a hazardous material), DOE had to comply with the Department of Transportation's regulations governing the transport of hazardous waste. According to DOE, complying with the regulations added approximately $11 million (in the years of the expenditure), or $1.75 per cubic yard of tailings, to the cleanup cost at the Grand Junction, Colorado site.[10] To comply with transportation requirements that mandated various inspections, DOE, among other things, hired a full-time transportation compliance officer, provided additional training for truck drivers on handling hazardous material, and purchased additional insurance.

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[8] The law required that the standards established under title I of the act provide protection that is consistent, to the maximum extent practicable, with the requirements of the Resource Conservation and Recovery Act of 1976, as amended. However, EPA's groundwater standards provided some flexibility; for example, allowing the groundwater to cleanse itself through natural flushing until the contaminants gradually decreased.

[9] Also, as discussed later, to comply with the new groundwater regulations, DOE had to clean up groundwater that had already been contaminated.

[10] DOE notes that because of the experience it gained at the Grand Junction site, the cost increases at other sites should be less than $1 per cubic yard of tailings.

Furthermore, under the requirements for hazardous materials, DOE also had to follow the requirements of the Occupational Safety and Health Administration, among others. For example, DOE had to provide full-time employees with a 40-hour training course on operations involving hazardous materials. DOE estimates that providing such training added about $600,000 (in the years of the expenditure) to the cost of cleaning up four Title I sites.

Discovery of Additional Tailings and Vicinity Properties Led to Additional Work and Increased Costs

The cleanup costs also increased because of the unexpected discovery of additional tailings at the sites. DOE's 1982 cost estimate was based on the assumption that about 19.3 million cubic yards of tailings would need to be cleaned up at the sites. By April 1995, this amount had doubled to 39 million cubic yards. According to DOE, the amount increased because the initial site characterization studies were limited. In addition, DOE had not anticipated the requirements it would need to meet when heavy metals and thorium were found at the sites. At some sites, these requirements increased the total amount of material to be cleaned up, which in turn increased the size of the needed disposal cell and the associated costs.

The vicinity properties also contributed to increased costs. As at many of the processing sites, DOE found more tailings than anticipated at some of the vicinity properties. For example, in Grand Junction, Colorado, the amount of tailings at the vicinity properties increased from an estimate of 747,000 cubic yards to almost 2 million cubic yards. Furthermore, additional vicinity properties were discovered, requiring cleanup work not included in the original estimate. In the early 1980s, DOE estimated that a total of 4,875 vicinity properties would need to be cleaned up. By October 1995, remedial actions were planned for 5,276 vicinity properties—an increase of about 8 percent.

State and Local Concerns Resulted in Changes in Cleanup Strategies, Thus Increasing Costs

State and local entities' concerns also affected the cleanup strategies selected and the attendant costs. For example, at the Grand Junction site, the local county's concern about safety led to the use of a train-and-truck method of transporting contaminated materials, rather than a cheaper truck-only method. Local officials wanted a transport system that avoided routing extensive truck traffic through heavily populated areas. The train-and-truck method required the construction of railroad transfer facilities and the manufacture of specially equipped containers. According to a DOE estimate, changing to the train-and-truck method cost an additional $28 million (in 1995 dollars) at the Grand Junction site.

The change to the train-and-truck method at the Grand Junction site also caused DOE to delay remedial action at three other Title I sites. According to a DOE program official, the additional unanticipated costs at the Grand Junction site required DOE to temporarily stop work at the Mexican Hat and Monument Valley sites and postpone planned work at the Ambrosia Lake site. DOE suspended work at the Mexican Hat and Monument Valley sites from February 1990 through December 1990, at an estimated cost of about $5 million (in 1995 dollars). According to DOE, at the Ambrosia Lake site, the remedial action was delayed by over a year, from April 1990 until July 1991, costing about $1.6 million (in 1995 dollars). In total, the change to the train-and-truck method at Grand Junction resulted in additional expenditures of about $34 million (in 1995 dollars).

In addition, according to an analysis by DOE, concerns expressed by the state and by local communities influenced DOE to change from on-site disposal to more costly off-site disposal at several locations, including Grand Junction and Gunnison, Colorado; Salt Lake City, Utah; and Riverton, Wyoming. These changes resulted in cost increases because they required additional site characterization and engineering, as well as additional construction activity.

DOE has construed the states' role as that of a full partner in selecting and performing the remedial action for each site. Although DOE believed that it was necessary to make the changes discussed above in response to the states' concerns, DOE program officials acknowledge that the changes did result in some additional expenditures.

Groundwater Cleanup Is in Planning Stages

DOE began work on its groundwater cleanup in 1991. Currently, DOE expects to complete its groundwater cleanup by 2014, at an estimated cost of at least $147 million, if the cleanup methods DOE has proposed are used. DOE's stated goal is to protect human health and the environment at the Title I sites by cleaning up the groundwater to EPA's standards. Although DOE has targeted potential groundwater cleanup strategies for the sites, it has yet to reach a final agreement with the affected tribes and states on what strategies will ultimately be used.

According to DOE officials, the Department will pursue those strategies that will enable it to comply with regulatory requirements at the least cost. Thus, wherever possible, DOE will either take no remedial action (leave the groundwater as it is) or allow the groundwater to cleanse itself through passive remediation (natural flushing) over time. Where necessary, DOE will use active remediation, such as pumping the groundwater out of the ground and treating it. DOE's proposed groundwater strategies call for taking no action at 13 sites, employing passive remediation at 9 sites, and using active remediation at 2 sites.

Status and Cost of DOE's Groundwater Cleanup Activities

DOE's groundwater cleanup effort is just beginning. Although EPA issued groundwater standards in 1983, the U.S. Court of Appeals for the Tenth Circuit remanded the standards to EPA. In 1987, EPA proposed new standards to replace those remanded. In 1988, Public Law 100-616 authorized DOE to clean up the groundwater at the Title I sites without any time limitation. DOE planned its groundwater program while the proposed rules were in effect. DOE began its groundwater cleanup effort in 1991. In January 1995, EPA published its final groundwater standards. Because the law established no deadline for completing the groundwater cleanup and because EPA had not issued its final standards, DOE delayed its efforts so it could concentrate instead on completing the surface cleanup, which had a fixed completion deadline. According to a Department official, DOE believed at the time that the groundwater cleanup would be expensive and lengthy. In addition, DOE believed it would have been inappropriate to begin the groundwater cleanup before the groundwater standards were finalized.

As of June 1995, DOE had spent about $16.7 million on activities related to the groundwater cleanup. Most of these expenditures were for (1) technical and management support, such as planning activities, and (2) site characterization, such as studying the extent and type of contamination and assessing the associated health risk. Although the groundwater cleanup had not been completed at any of the Title I sites as of November 1995, DOE is forecasting that its sites will meet EPA's groundwater standards by 2014. On the basis of the cleanup strategies it will propose to the affected states and Indian tribes, DOE estimates that the groundwater cleanup will cost at least $147 million.

As a major step in implementing its proposed cleanup strategies, DOE intends to modify its existing cooperative agreements with the affected states and Indian tribes to more explicitly address groundwater issues. DOE intends to modify these agreements to reflect the needed funding, actions concerning real estate, and technical reviews necessary to perform the chosen remedial action. As of October 1995, DOE had not completed any modifications to the agreements with the affected parties.

In addition to modifying the cooperative agreements, DOE plans to obtain comments from the affected states and Indian tribes on a major planning document[11] that provides the framework for the groundwater cleanup program, as well as on other technical documents.[12] Once DOE has received comments from the affected states, tribes, and citizens on these documents, it plans to draft a remedial action plan for each site.

DOE's Proposed Cleanup Strategies Are Based on Risk Assessment and Applicable EPA Standards

DOE is currently formulating groundwater cleanup strategies that will comply with EPA's standards, on the basis of health and environmental risk assessments and the potential use of the water. According to EPA's groundwater standards, DOE should apply the most cost-effective cleanup remedies available to meet these standards at each site. The standards establish concentration limits for those contaminants expected to be found in the groundwater as a result of uranium processing at the sites. According to DOE, EPA set the following four standards for DOE's use:

- Maximum concentration limits. This standard is intended to protect human health and the environment from the many contaminants that can occur at a site. For each contaminant, the standard establishes a maximum concentration limit. For a site to meet this standard, these limits cannot be exceeded.
- Alternate concentration limits. Under this standard, contamination levels can be higher than those allowed under the standard for maximum concentration limits. DOE may apply to NRC to use the alternate standard if it can demonstrate that human health and the environment are still protected, even though the contamination levels exceed the maximum concentration levels.
- Background level. This standard may apply at sites where nearby water, while not contaminated by contaminants resulting from uranium processing, is of naturally poor quality (e.g., because of high levels of mineral concentration). If the contaminants have not reached the maximum concentration levels or if the quality of the background water

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[11] Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Groundwater Project, draft, DOE

[12] These documents include the site work plans, which provide detailed characterization of the sites and environmental assessments

exceeds the maximum concentration levels, DOE may choose to clean up the groundwater only to the background level standard.

- Supplemental standards. This standard may apply at sites under special circumstances, such as the following: (1) the groundwater is not a current or potential source of drinking water because of its poor quality or limited quantity, (2) the groundwater cleanup would cause more harm than good to the environment, or (3) the cleanup is not technically feasible. In such cases, DOE may apply to NRC to use the supplemental standards and leave the groundwater as it is.

DOE's Proposed Cleanup Strategies Vary Considerably

After assessing the applicability of EPA's various groundwater standards at each site, DOE developed proposed cleanup strategies for 24 sites. These proposed strategies are (1) no further action at 13 sites, (2) passive remediation at 9 sites, and (3) active measures to clean up the contamination at the 2 remaining sites.[13] When no health risk is demonstrated, DOE may decide that no cleanup action is necessary. Or, depending on its assessment of risk, DOE may decide to use a passive cleanup, such as a natural flushing approach. At sites where DOE believes that it is necessary to protect health and the environment, the Department may initiate a more active cleanup strategy, such as pumping and treating the groundwater. Regardless of the strategy it chooses, DOE must obtain NRC's concurrence.

At 13 sites, DOE believes that no groundwater cleanup activities are warranted and so has proposed no further action at these sites. If DOE's proposal is accepted, the cost of the groundwater activities at these 13 sites will be primarily for activities such as studying the sites (e.g., to identify the type and level of contamination), holding public meetings, and working with NRC. DOE believes that its proposal to take no further action at these 13 sites will comply with EPA's groundwater standards as long as the groundwater contamination does not exceed the background levels or maximum concentration limits, or as long as supplemental standards are applicable on the basis of limited use of the groundwater.[14]

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[13] Because the proposals shown are DOE's projections and are for planning purposes only, they are subject to agreements reached with the affected states and tribes and the completion of the final site-specific documents.

[14] Groundwater may be classified as "limited use" if the total dissolved solids exceed 10,000 milligrams per liter, if there is widespread ambient contamination that cannot be cleaned up using treatment methods reasonably employed in public water supply systems, or if the quantity of water available is less than 150 gallons per day.

"No further action" can mean one of three things, which DOE breaks down as follows:

- The site's groundwater is not contaminated. DOE characterizes this condition, which has occurred at one of the Title I sites, as "no further action."
- The groundwater is contaminated, but conditions at the site warrant the use of the supplemental standards or alternate concentration limits. DOE characterizes this condition, which has occurred at six sites, as "no further action, compliance demonstration."
- Insufficient data on groundwater were collected at the site during the surface cleanup, so that additional data must be collected to demonstrate that the supplemental standards should be used. DOE characterizes this condition, which has occurred at six sites, as "demonstrate compliance through additional characterization."

DOE believes that nine sites are candidates for passive remediation, or natural flushing. Although the cleanup of the groundwater contamination at these nine sites may take up to 100 years to complete, DOE estimates that, except for long-term monitoring, its work will be completed by 2014. By that time, DOE will need to show that the cleanup of the groundwater is occurring at such a rate that the cleanup will be completed within 100 years.

As noted above, passive remediation means performing no cleanup and instead relying on natural flushing. Natural flushing cleans groundwater through the process of dilution. Over time, as the groundwater flows through the aquifer, the concentration of contaminants gradually decreases. EPA's regulations require monitoring to verify the movement of contaminants in the groundwater and the related reduction in contamination. DOE plans to continue monitoring the sites for 30 years and then demonstrate through its groundwater models that the process will result, within 100 years, in a level of cleanliness that meets the applicable EPA standard.

DOE believes that natural flushing is a viable cleanup strategy when (1) it will protect human health and the environment, (2) it will reduce the concentration of contaminants to a level below that prescribed by the standards in less than 100 years, and (3) the groundwater is not used for and is not expected to be used for drinking water. If natural flushing is chosen, access to the contaminated groundwater must be restricted through means such as monitoring and controlling the site's boundaries and developing and enforcing land-use policies.

According to a DOE official, the federal government has never used natural flushing as a cleanup strategy. However, EPA believes that natural flushing is a viable alternative when (1) water use and ecological considerations are not affected and (2) the cleanup will occur in less than 100 years. Furthermore, EPA believes that institutional controls, if enforced by governmental entities or installed with a high degree of permanence, can be relied upon for up to 100 years.

Finally, at some sites a passive compliance strategy may not comply with the applicable EPA standards, may not adequately protect human health or the environment, or may not be accepted by the public or the affected community. Under these circumstances, DOE will propose an active strategy for the groundwater cleanup. For example, DOE may propose (1) pumping out the contaminated groundwater, treating it, and discharging it on the surface or (2) adding nutrients to the groundwater to promote bacterial growth that will break down the contaminants into nonhazardous elements (known as bioremediation).

DOE believes that two sites—Monument Valley and Tuba City, Arizona—are candidates for active remediation because natural flushing at these sites would not clean the groundwater within 100 years. These two sites are located on lands belonging to the Navajo and Hopi Indian tribes. According to DOE officials, tribal officials are supporting active remediation of the groundwater. In addition, although the groundwater is not currently being consumed by people, the contaminants associated with the groundwater at both sites could cause death if ingested by infants.

DOE's Future Costs Are Uncertain

The ultimate extent and cost of DOE's surface and groundwater cleanups depends on the resolution of a number of issues. First, while the surface cleanup of the Title I sites is completed or progressing at the majority of the sites, it will not be completed by the end of fiscal year 1996, when DOE's legislative cleanup authority expires. Second, because the groundwater cleanup is in its early planning stages, as discussed in chapter 2, its final scope and cost depend largely on the methods chosen to conduct the cleanup and the financial participation of the affected states. If DOE's proposed least-cost approaches are not chosen, the project's costs will increase accordingly. In the event that any state is unwilling or unable to share the cost of the groundwater cleanup, DOE will notify the Congress that it cannot complete the cleanup in those locations. Third, if the Congress provides for disposal of additional tailings in Grand Junction, Colorado that are unearthed in the future, DOE will incur added costs. Finally, NRC's regulations specify that it make a one-time minimum charge to the owners/operators of Title II sites of $250,000 in 1978 dollars ($530,000 in 1995) to pay for the basic surveillance costs at each site. This amount has not been reviewed and updated since 1980 and excludes any amount for ongoing maintenance. DOE's estimates of the annual costs of surveillance and maintenance at the sites indicate that NRC's expected minimum charge may be understated.

Various Factors May Affect Schedule and Cost of Surface Cleanup at Title I Sites

Although DOE plans to complete most of its surface cleanup by the end of fiscal year 1996—when its legislative cleanup authority expires—the Department believes it unlikely that work at some sites can be completed by then. At those sites, DOE anticipates it could complete the cleanup by early 1997. The licensing of these sites will continue into 1998 and DOE has established a goal of completing all licensing activities by the end of 1998 However, NRC officials are less optimistic that all the licensing will be completed by this date.

Completion of Surface Cleanup Depends on Resolving Problems at Five Sites

According to a DOE official, if the Department receives a 2-year extension of its cleanup authority, it can complete the surface cleanup of all the Title I sites by the beginning of 1997. Work has already been completed at 15 sites, and at another 4 sites, cleanup is progressing on schedule and completion is expected before the end of fiscal year 1996. For example, at the two Rifle, Colorado, sites, hauling of the tailings is complete, the radon barrier will be completed in October 1995, and the disposal cell's rock cover should be in place by May 1996, as scheduled. The cleanup at two other sites (Gunnison and Maybell, Colorado) is scheduled for completion in November 1995 and January 1997, respectively. At the remaining five sites, however, progress has been hampered by outstanding issues.

At the Naturita, Colorado, site, the cleanup is scheduled for completion during fiscal year 1997, contingent on NRC's concurrence with DOE's site cleanup and disposal plan for the site, which DOE hopes to obtain in December 1995. Work at the Naturita site was delayed when DOE, in response to public pressure, changed the location of the disposal cell. Once a new location was selected, work began on the disposal cell's design, but construction of the disposal cell cannot begin until NRC concurs with the plan. Accordingly, in an attempt to speed the process, DOE skipped the first two steps of its typical three-step process for obtaining NRC's concurrence. The first two steps essentially involve obtaining NRC's early review of the preliminary plans. Because it skipped the early review steps, however, DOE is less certain than it has been in other cases that NRC will accept the plan without major modifications. Yet DOE must obtain NRC's concurrence by December 1995 in order to begin construction in the spring of 1996 and complete the cleanup of the site in 1997. According to NRC officials, the Commission received the remedial action plan for this site on November 14, 1995. As a result, although NRC is giving this review a high priority, because of the late submission of the documentation, NRC cannot guarantee completion of the review by the end of 1995.

The cleanup of the two sites located at Slick Rock, Colorado, has also been slowed by problems with a subcontractor's performance. Work at the two sites began during the spring of 1995. However, the subcontractor's poor performance resulted in slow progress, and in October 1995 a decision was made to terminate the contract. DOE estimates it will cost about $4.6 million (in 1995 dollars) to terminate the project and rebid the work.[1] As of September 1995, the project was 6 months behind schedule. Nonetheless, DOE currently expects the cleanup at this site to be completed in fiscal year 1997, as projected.

Finally, DOE's schedule for completing the cleanup could also be affected by its decision on whether to clean up the two North Dakota sites or "de-list" them (drop them from the program). As indicated in chapter 1, DOE added these two sites to the original list of 22 Title I sites early in the program.[2] However, in March 1995 the North Dakota State Department of Health and Consolidated Laboratories requested that DOE remove the two sites from the program because North Dakota's legislature was not likely to appropriate funds for the state's 10-percent share of the cleanup costs. The state also felt that there would be minimal risk to the public and environment if the sites were not cleaned up and that the benefits associated with the cleanup were not commensurate with the costs.

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[1] These costs are for the extended opening of the field office at Slick Rock, the rebidding of the contract, and attorneys' fees

As of October 1995, DOE had made no decision about de-listing the sites but had initiated the process that could lead to doing so. If DOE ultimately decides to de-list the two sites, the schedule would not be affected since the sites would no longer be part of the program. However, if the sites are not de-listed and the state is willing to pay its share of the cleanup costs, the work at the sites may not be completed by the end of 1997. According to DOE officials, preparation for remedial action at the two sites would have had to begin by mid-September 1995 in order to complete the cleanup by the end of fiscal year 1997.

If North Dakota does not pay its share of the cleanup costs, DOE believes it would not have the authority to complete its cleanup. According to DOE, if a state cannot pay its 10-percent share of the costs, the Department would notify the Congress that it could not complete the remedial actions planned in that state.

DOE officials told us that the Department has a goal of completing all licensing of the Title I sites by the end of 1998 and is working closely with NRC to meet this goal. However, NRC officials are less than optimistic that the Commission will be able to license all the sites by then because of their workload at the Title II sites.

By late spring of 1996, if its authority has not been extended beyond the end of fiscal year 1996, DOE plans to start shutting down its work at those sites where the cleanup is not complete. Doing so, however, would be costly. According to a DOE official, the activities required to shut down a site (e.g., completing the paperwork required to terminate contracts and release or reassign employees, paying penalties to contractors, covering exposed tailings, and fencing work sites) would cost at least $15 million (in 1995 dollars) at four sites: Maybell, Naturita, and the two Slick Rock sites. Furthermore, the costs would be even higher if DOE starts, and then subsequently needs to stop the cleanup work at the two North Dakota sites.

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[2] According to DOE's Deputy General Counsel, by authorizing the Secretary to use discretion in adding to the list of sites designated by the Congress, the act implicitly authorizes the use of discretion in reconsidering how such sites are designated if additional information comes to light. Thus, if these two sites were not properly designated in 1979, DOE could revoke their designation.

DOE May Face Added Costs at Cheney Disposal Cell

DOE is working with NRC and the state of Colorado to develop a long-term radon management plan for disposing of tailings unearthed in the Grand Junction, Colorado, area, in future years. About a million cubic yards of tailings were used in burying utility lines and constructing roads in the area and remain today under the utility corridors and road surfaces. In future years, utility and road repairs and replacements will likely cause tailings to be unearthed, resulting in a potential public health hazard if the tailings are mismanaged.

In response to this problem, DOE is working with NRC and Colorado officials to develop a plan that calls for temporarily storing the tailings as they are unearthed and periodically transporting them to the nearby disposal cell (the Cheney cell located near Grand Junction, Colorado) for permanent disposal. The city or county would be responsible for hauling the tailings to the cell, and DOE would be responsible for the cost of placing the tailings in the cell. Under the plan, a portion of the Cheney disposal cell would remain open, at an annual cost of several hundred thousand dollars. This portion of the cell would remain open until it is full or for a period of 20 to 25 years, according to a program official.

Because the law requires that all disposal cells be closed upon completion of the surface cleanup work, DOE does not have the authority to implement this plan without congressional approval to keep a portion of the Cheney cell open as far into the future as necessary.

Uncertainties May Increase Scope and Cost of Groundwater Cleanup

As discussed in chapter 2, DOE is developing a groundwater cleanup strategy that meets EPA's standards while using the least-cost approaches wherever possible. However, DOE is uncertain whether the affected states and Indian tribes will agree with its proposed approaches and, if not, to what extent their disagreement will influence DOE's choices. DOE plans to negotiate the selection of groundwater strategies with the affected states and tribes. Historically DOE has construed the states' role as that of a full partner in selecting and performing remedial actions. However, according to DOE, it has not allowed and does not plan to allow the states and tribes to exercise veto authority over the selection of the remedy.

Until DOE (1) modifies its cooperative agreements with the affected states and tribes to incorporate groundwater activities and (2) finalizes the documents pertaining to each site, such as site characterization studies and environmental assessments, the Department cannot be sure what it will cost to complete the groundwater cleanup. As of October 1995, DOE was negotiating with the state of Texas to modify its cooperative agreement and incorporate provisions for complying with the groundwater program. Texas has tentatively accepted the proposed modification to its cooperative agreement, and DOE plans to use the modified Texas cooperative agreement as a model for other states. However, DOE does not know if other states will accept such modifications. According to DOE, it is premature to speculate on how a state's refusal to modify the cooperative agreement could affect the Department's strategy for the groundwater cleanup.

DOE estimates that implementing its proposed strategies for the groundwater cleanup would cost at least $147 million. This cost estimate, however, is based in large part on the technical assumptions underlying the selected strategies. As a result, the final cost is difficult to project because the technical assumptions may be proven invalid by the future testing and monitoring that DOE plans to conduct. According to a DOE official, examples of these assumptions are the (1) rate of speed that contaminant particles move through the aquifer and (2) volume of contaminants in the aquifer. According to EPA,[3] "[t]he cleanup of groundwater is a large-scale undertaking for which there is relatively little long-term experience." EPA also noted that the condition of the groundwater at the Title I sites varies greatly and that the "engineering experience with some of the required remedial actions is limited."

While it has targeted the least-cost strategies for cleaning up the groundwater at each site, DOE has identified five sites where it believes there is a 50-percent chance that a more expensive alternative may be required. DOE may choose a more expensive alternative because (1) the affected states or Indian tribes, through negotiations, may influence the Department to select a more expensive alternative because of their disagreement over DOE's proposed cleanup strategy or (2) future studies by DOE may prove that the technical assumptions are invalid. As a result, for each of these five sites, DOE has identified an alternative strategy that, although more expensive, may address concerns raised by the affected entities or possible technical problems.

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[3] Discussed in EPA's Jan. 11, 1995, groundwater standards.

DOE estimates that implementing the more expensive alternative approaches at these five sites would cost an additional $72 million, thus raising the total cost of its share of the groundwater cleanup to $219 million. According to DOE officials, however, the Department is looking for ways to reduce the cost of the groundwater cleanup.

In addition, although the states are to pay 10 percent of the cost of remedial actions, DOE has not yet specified when the states would begin to share in these costs. If DOE decides that for groundwater cleanup, as for the surface cleanup, the states will share only in the cost of the groundwater remediation plans and remedial action (and not such items as administrative costs), then the states' estimated total cost share would be about $1 million, according to DOE.

Finally, some states may not have funds to pay their share of the groundwater cleanup cost. According to a DOE official, Pennsylvania, Oregon, and Utah may not have funding for the groundwater program. A Colorado official has also indicated that the state legislature may not provide funding unless it can be shown that the contaminated groundwater poses a serious health risk.

According to DOE, if the states do not provide funds for their share of the costs, it would not have the legislative authority to clean up the sites. The Department has not finalized any contingency plans in the event that the states are unable to pay their share but is considering a variety of options, including offsets and in-kind services from the states (e.g., equipment and construction services) in lieu of financial support. However, if an adequate solution is not found, DOE maintains that it will not clean up the affected sites without congressional authorization.

DOE Is Responsible for Long-Term Custody of Title I and II Sites, but Uncertainty Surrounds Costs of Long-Term Care

DOE's responsibilities for the Title I sites do not end when the surface and groundwater cleanups are complete. DOE will be responsible for the long-term custody (i.e., surveillance and routine maintenance) of both Title I and II sites.[4] The Department estimates that its long-term custodial activities for about 45 Title I and II sites will cost about $60 million (in 1995 dollars) between 1995 and 2030.[5] While DOE is financially responsible for the long-term custody of the Title I sites, NRC's regulations require the owners/operators of the Title II sites to pay the long-term costs associated with routine maintenance and surveillance for their sites. The underlying assumptions on which these regulations are based have not been updated and may not reflect current cost estimates for long-term surveillance and maintenance.

DOE Will Be Responsible for Custody of Title I and II Sites

Over the coming years, DOE is expected to acquire long-term custody of its Title I sites and most or all of the Title II sites. DOE estimates that, after 2010, it will be responsible for monitoring and maintaining 19 Title I sites[6] and 26 Title II sites. Although states have the option of assuming long-term custody of the cleaned-up Title II sites, DOE does not expect that any state will choose to do so. Accordingly, DOE expects to acquire custody of all 26 Title II sites. DOE has estimated that it will spend $60 million (in 1995 dollars) between fiscal year 1995 and fiscal year 2030 on its responsibilities for long-term custody at the Title I and II sites. (DOE has not projected its costs past 2030.)

NRC's Minimum Charge for Long-Term Surveillance Costs Has Not Been Reviewed and Updated and Does Not Include Routine Maintenance

Under the act, NRC is responsible for ensuring that before the federal government takes custody of a Title II site, it makes financial arrangements with the owners/operators adequate to cover the costs of long-term custody so that they, not the federal government, bear these full costs. Under its regulations,[7] NRC, is to collect a one-time charge from the owner/operator of each site "such that, with an assumed 1 percent annual real interest rate, the collected funds will yield interest in an amount sufficient to cover the annual costs of site surveillance." The money is to be paid to the General Treasury of the United States before the site's license is terminated.[8]

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[4] DOE will also acquire long-term custody of about 10 other sites that were contaminated by activities conducted in support of the nation's nuclear energy programs. These sites include former government facilities for nuclear power research, development, and production.

[5] Although DOE has developed cost estimates only through 2030, its long-term custody responsibility will continue indefinitely.

[6] The total number of disposal cells is lower than the number of Title I sites because in some cases tailings from two sites were combined and disposed of in the same cell.

[7] 10 C.F.R. Pt. 40, App. A (1995).

NRC's regulations specify a minimum one-time charge to cover long-term surveillance costs. If it is determined that the sites' surveillance or control requirements are significantly greater than general surveillance requirements, a larger charge could be made. In 1980, NRC estimated that the minimum annual surveillance charge per site would be $2,500 in 1978 dollars (or $5,300 in 1995 dollars). Using a real interest rate of 1 percent, a fund of $250,000 per site in 1978 dollars—$530,000 in 1995 dollars—would provide continuous interest income to cover the estimated annual costs. At that time, NRC expected that the only cost for long-term surveillance would be the cost of the time and effort involved in government inspectors' visits to sites (i.e., travel time, inspections, and preparation and follow-up for the inspections).

NRC's minimum charge for surveillance was based on the assumption that ongoing maintenance would not be necessary. However, the regulations provide that the maintenance costs could be added to the charge. According to NRC, some routine maintenance—such as repairing fences, filling in minor erosion, or eliminating rodents—is recognized in the regulations as a possibility for all sites. If NRC determines on the basis of site evaluations that maintenance will be necessary, additional funds may be required.

DOE, which will take custody of the sites, has a different view of the minimum annual surveillance cost and the need for routine maintenance. On the basis of its experience with the Title I sites, DOE estimates that minimum annual cost of surveillance at the Title II sites will consist, in 1995 dollars, of (1) $6,000 for an annual inspection and, if necessary, a follow-up inspection and (2) $10,000 to prepare an annual inspection report. DOE officials acknowledge that the costs for annual site inspection and report preparation have been decreasing. As the number of licensed Title I and II sites increases, inspection visits can be combined because many of the sites are located near each other.

DOE also believes that annual routine maintenance will be required at each Title II site and will cost $5,000 (in 1995 dollars) annually. Maintenance, according to DOE's guidance,[9] includes both "routine" (scheduled) and

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[8] If the state in which the site is located chooses to assume responsibility for the site's long-term custody, then the money is paid to the state's treasury.

[9] Guidance for Implementing the UMTRA Project Long-term Surveillance Program, DOE, Sept. 1992.

"unscheduled" activities. Among the scheduled activities are mowing grass, maintaining access or perimeter roads, and removing accumulated weeds or debris. Unscheduled maintenance will be conducted as needed for purposes such as preventing animal burrows or deep-rooted vegetation from entering a disposal cell. Thus, DOE estimates that the combined annual surveillance and maintenance costs will be $21,000 (in 1995 dollars).[10] According to NRC officials, however, DOE's $21,000 estimate is provided without a basis and therefore cannot be verified as accurate.

If DOE's estimate of the minimum annual surveillance costs and the need for routine maintenance is correct, the minimum charge cited in NRC's regulations will not yield sufficient income to cover the annual costs. To update NRC's calculation of the amount the operators will have to pay in order to cover these costs, we used the 1-percent real annual interest rate specified in NRC's regulations and DOE's estimates of annual costs—$16,000 for surveillance or $21,000 (in 1995 dollars) for surveillance and maintenance.[11] According to our calculations, $1.6 million (in 1995 dollars) would be needed to cover annual costs of $16,000, and $2.1 million would be needed to cover annual costs of $21,000. As noted earlier, the one-time charge based on NRC's 1980 estimates would amount to only $530,000 (in 1995 dollars) and yield $5,300 annually.

Conclusions

DOE has completed much of its surface cleanup at the Title I sites but will not finish the cleanup by its legislatively mandated deadline of September 30, 1996. To complete the surface cleanup work, DOE will need at least a 2-year congressional renewal of its surface cleanup authority. DOE is currently seeking reauthorization of the surface cleanup program through fiscal year 1998. However, costs will continue after the surface cleanup has been completed.

DOE is uncertain about the ultimate cost of its groundwater cleanup program, which is now only in its infancy. It is too early to know whether the affected states or tribes will ultimately persuade DOE to implement more costly remedies than the strategies the Department has proposed. DOE is also unsure about the validity of the technical assumptions underlying its proposed strategies. As a result, DOE may ultimately choose more expensive cleanup strategies, increasing the final cost of the groundwater cleanup by as much as $72 million. However, until DOE, the states, and the affected Indian tribes have reached a final agreement and more is known about the accuracy of DOE's technical assumptions about the proposed methods, the final cost of the groundwater cleanup cannot be ascertained.

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[10] DOE expects that the annual surveillance costs will be the same for both Title I and II sites. Although DOE has projected its surveillance costs over the next 30 years, its responsibility for surveillance extends into perpetuity.

[11] NRC used a 1-percent interest rate because that was the average rate over the period 1951-79

Furthermore, DOE has yet to determine whether the states are willing and able to pay their share of the cost of the groundwater cleanup. Because DOE believes that it is prohibited from cleaning up contamination without the states' full financial participation, if the states do not provide their 10-percent share of the cleanup cost, DOE will not move forward on the cleanup without congressional authorization.

In addition to the cost of the groundwater cleanup, DOE may incur further costs to dispose of tailings that are unearthed in the future in the Grand Junction, Colorado, area. DOE's disposal of such tailings, however, will be contingent upon obtaining congressional authority to do so.

The basis for NRC's minimum long-term surveillance charge has not been updated and does not reflect DOE's current estimates of what it will cost to provide annual surveillance and maintenance. NRC has not reviewed its estimate of basic surveillance costs since 1980, and DOE is currently estimating that basic monitoring will cost about three times more than NRC estimates. Moreover, while DOE maintains that ongoing, routine maintenance will be needed at all sites, NRC's minimum charge does not provide any amount for ongoing maintenance.

Matters for Congressional Consideration

The Congress may wish to consider authorizing DOE to keep a portion of the Cheney disposal cell open to dispose of tailings that are unearthed in the future in the Grand Junction, Colorado, area. In addition, to resolve the issue of DOE's lack of authority to complete the groundwater cleanup if the states do not contribute their 10-percent share of costs, the Congress may wish to consider whether and under what circumstances DOE can complete the cleanup of the sites when the states do not provide financial support.

Recommendation

To provide a realistic indication of the future costs for long-term surveillance and maintenance of the Title II sites, we recommend that the Commissioners of the Nuclear Regulatory Commission direct its staff to consult with the Department of Energy to develop an accurate estimate of these costs and what they entail, and use that information to (1) update the minimum one-time charge for basic surveillance and (2) determine if routine maintenance will be required at each site, and, if so, incorporate those costs into the minimum charge.

Agency Comments and Our Evaluation

In addition to the technical corrections provided by DOE, EPA, and NRC officials, NRC commented on our recommendation that the Commission update its one-time charge for basic surveillance and determine the need for routine maintenance at each site. NRC believes that our recommendation to update the minimum one-time charge for basic surveillance presumes that the initial assumptions it used in developing its basic charge for surveillance may no longer be valid. NRC is not certain that these assumptions are invalid but is nonetheless reexamining the issue.

NRC officials fully agreed with our recommendation to determine the need for routine maintenance at each site and incorporate any resulting costs. These officials cited several steps the Commission is taking to ensure that the recommendation will be implemented. They said that the Commission and DOE are preparing a working procedure that both agencies will use in the licensing process—including how NRC will determine long-term funding for the sites and what role DOE will play. NRC is also developing a procedure to follow in granting a license, including guidance on how to determine the amount needed for long-term funding and on the information needed to justify this funding amount. Finally, NRC plans to discuss long-term funding requirements with the owners/operators of the Title II sites and with DOE.

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Chairman ROHRABACHER. Dr. Colglazier.

STATEMENT OF DR. E. WILLIAM COLGLAZIER, EXECUTIVE OFFICER, NATIONAL ACADEMY OF SCIENCES AND NATIONAL RESEARCH COUNCIL, WASHINGTON, DC

Dr. COLGLAZIER. Thank you, Mr. Chairman and Mr. Roemer, for the opportunity to be here, and I'll try to summarize briefly my written testimony.

We at the National Research Council, which is the operating arm of the National Academy of Sciences and the National Academy of Engineering, are quite familiar with the Environmental Management Program. I've brought with me, and I believe we provided to your staff, some of the recent reports that we've done related to this program.

In fact, I would commend to the Committee the fact that to an unusual degree for a government agency, the EM Program has been willing to subject itself to a great deal of objective outside review, especially from the National Research Council, which indicates a willingness to find and correct problems and to make improvements in the program.

We recently conducted a broad assessment of the performance of the EM Program which was requested by the Department. We have also recently evaluated the Department's efforts on decontamination and decommissioning which I know is important to this Committee.

In addition, we have conducted a number of studies on particular aspects of the program, and I'll try to just briefly highlight some of these reports. Our work has brought to light a number of issues and problems. However, it is also clear to us that the Department has achieved a number of successes and is committed to improving the organizations and operations of the EM Program.

Let me begin by first mentioning a study that was first requested by the Department in 1993 called "Building Consensus Through Risk Assessment and Management of the EM Program." I might also mention that for all of our committees, the people who serve on our committees do it as volunteers and they receive no compensation for serving on our committees. And also when they produce their draft report, it goes through an exhaustive review process before it is released to the public.

In this particular case with this committee, they received input from a large number of stakeholders in the DOE program; and in fact they had workshops that involved satellite hookups to over 300 sites.

The report of this committee found that the use of risk assessment as one of the tools in setting priorities is feasible and advisable.

An important further finding, which is captured in the title, "Building Consensus Through Risk Assessment and Management," is that rigorous, consistent and continuous inclusion of stakeholder groups in the effort of risk assessment can become an important element in building a consensus on the key decisions that need to be made in the remediation of sites.

I'm pleased to say regarding this report, that the recommendations have been embraced by the Department and have become central themes of incorporation of risk assessment as a decision-making tool in the cleanup of DOE sites.

Let me mention a second report, which was a major effort in reviewing all of the program, entitled “Improving The Environment, an evaluation of DOE’s Environmental Management Program.” This study was requested by Tom Grumbly, then the Assistant Secretary, and now the Acting Under Secretary. This report examined four issues, regulatory measures, priority setting, utilization of science and technology and organization and management.

First of all, some of the things that they praised in the Department and I think the Department ought to be commended on were:

The recently announced research and development initiative which is aimed at bringing the Department’s and others’ basic research capabilities to bear on the cleanup problem;

The introduction of a performance-based integrated contract that includes the elements of a Department contract reform initiative;

The integration of risk and long-term cost data into the budgeting process;

And a substantial and effective effort to improve stakeholder participation.

Let me just briefly highlight some of the key recommendations from this major overview study.

First of all, on the issue of environmental management, the committee felt should use the concept, responsible stewardship, which means undertaking appropriate near-term or mid-term action to remediate a site to protect the public and the environment when a permanent solution is not at hand.

In the absence of permanent solutions, responsible stewardship allows progress to be made by providing adequate protection against environmental and human health risks that are serious and long-lived.

On the issue of land use planning, effects on land use and groundwater should be among the first considerations in the planning of remediation. There is also a need for a formal decision-making framework for future land-use and cleanup standards.

On the issue of incentives and accountability, the committee felt that in the short term, an effort to improve incentives, metrics and accountability of Federal employees and contractors is the most effective way to improve the performance of the EM Program in meeting its goals, lowering its cost and improving its safety.

On priority setting, the committee felt that any priority-setting system and its attendant tools must be placed in an overall organizational framework to be effective. The success of a priority-setting system depends on how well it is implemented. The Department needs to develop performance standards and metrics to measure as quantitatively as possible its performance and progress.

Among the key goals for the Department are target cleanup levels, magnitudes of occupational risk to be tolerated, end uses of former facilities and the role of repositories in the overall program.

On the use of science and technology, which obviously has to play a key role in all the activities of the EM Program and are vital for improving the performance and safety in the longer term, the committee felt that the decision as to whether national laboratories, universities or industry should take the lead in the basic research effort or in the development of any particular technology should be based on a competitive process that undergoes external review and not on a formula or some other form of entitlement. Teaming together and partnering these different groups, such national laboratories and universities, is often the most effective approach.

On regulatory measures, the committee felt that the Department's self-regulation of its nuclear-related activities should be eliminated and an appropriate outside agency found to carry out these responsibilities.

In a number of instances in which the Department and its contractors cite regulatory restrictions as prohibiting common sense and safe solutions to their problems, there is usually some form of regulatory flexibility that has not been applied. The committee felt that the Department should encourage the Environmental Management Program and its contractors to use the available flexibility.

They also recommended that if more than one regulatory entity has jurisdiction over a Department site, that a lead regulator should be designated for a given operable unit.

On public participation, the committee felt that involving stakeholders is crucial for creating a workable consensus whether the issue is the decision process for technology selection or the performance of a risk assessment for remedial action options.

Let me just also briefly mention some of the other recent reports. Many of them have been conducted by our Board on Radioactive Waste Management and its standing committees.

One committee is the Committee on Environmental Management Technologies which recently undertook a review of the Department's programs dealing with the development of environmental management technologies. This committee has looked at technologies for containment of plumes, landfill stabilization, high-level radioactive waste tank remediation, mixed waste characterization and treatment and facility decommissioning and disposition in two recent reports, one in 1994 and in 1995.

A second committee looking at remediation of buried and tank waste was organized in 1992 to review primarily the programs at the Idaho site and the Hanford site.

There are three recent reports which I might mention:

One is "The Potential Role of Containment-in-Place in an Integrated Approach to the Hanford Reservation Site Environmental Remediation";

A second report is called "Barriers to Science: Technical Management of the Department of Energy's Environmental Remediation Program." This report identifies and comments quite candidly on several problems related to the management of ongoing cleanup efforts in the weapons complex;

And a third report is titled "Safety of the High-Level Uranium Ore Residues at the Niagara Falls Storage Site in the State of New York."

Another committee which recently completed its report for DOE looked at separations technology and transmutation systems. It was convened at the request of the Secretary to evaluate the effects, costs and feasibility of employing separations and transmutation technologies for managing spent nuclear fuel from nuclear reactors and radioactive wastes in tanks at DOE sites.

We've also created a new committee at the request of the Department which is to evaluate the new basic science program which the Department has initiated this year. This committee will be commenting and making recommendations on the implementation of this new basic science initiative.

And, lastly, I'll mention a report on decontamination and decommissioning of the gaseous diffusion plants in the DOE complex which was completed by our Board on Energy and Environmental Systems. The Board made a thorough study of the uranium enrichment facilities throughout the complex and made several recommendations including:

The effort for the three gaseous fusion plants is essentially a large deconstruction and demolition project that can be effectively undertaken in the near term;

Based on the experience with other decontamination and decommissioning projects, previous cost estimates to carry out the demolition and deconstruction of these three plants are too high, and there are opportunities for major cost reductions;

And, lastly, proven technologies are available for effective decontamination and decommissioning of these gaseous diffusion plants.

As you can see, Mr. Chairman, the National Research Council has a high degree of familiarity with many of the aspects of the Environmental Management Program. This program faces enormous challenges and problems, but progress is being made, and the Department deserves high marks for subjecting its efforts to outside independent review, and we have found them to be very responsive to our suggestions.

Again, thank you for this opportunity to testify.

[The prepared statement of Dr. Colglazier follows:]

E. WILLIAM COLGLAZIER

Executive Officer
National Academy of Sciences and National Research Council

on
The DOE's FY1997 Budget Requests for Environment, Safety and Health, Environmental Restoration and Waste Management (Non-Defense) and Nuclear Energy

before the

Subcommittee on Energy and the Environment
of the
Committee on Science

May 1, 1996

Mr. Chairman, and Mr. Roemer, my name is Dr. William Colglazier. I am the Executive Officer of the National Academy of Sciences and the National Research Council. We at the National Research Council are very pleased to provide you some of our insights about the Environmental Management program at the Department of Energy. As you will learn, the NRC is very familiar with the program. In fact, I would commend to the committee the fact that to an unusual degree, the EM program has been willing to subject itself to a great deal of objective, outside review, especially, from the National Research Council, which indicates a willingness to find and correct problems and to make improvements in the program.

First, let me briefly describe what the NRC is and how we work. I do this because is important for an understanding of the value of our recommendations. The Academy was chartered by Congress and signed into law by Abraham Lincoln. It differs from most other Academies of Science in the world in that it is not just an honorific Academy. From the outset it was established to provide independent advice to the government on matters of science and technology. It does so through the NRC, which is the operating arm of the National Academy of Sciences and National Academy of Engineering. Using thousands of experts from academia, industry, and other organizations who volunteer their time, the NRC produces about 200 report per year.

The National Research Council has conducted a number of studies on the EM program and has others underway. We recently conducted a broad assessment of the performance of the program, which was requested by the Department. We have also recently evaluated the Department's efforts on Decontamination and Decommissioning, which I know is important to this committee. In addition, we have conducted studies on particular aspects of the EM program. Many of these latter studies have been carried out by our Board on Radioactive Waste Management and its standing committees, which have been reviewing the activities of this program and its predecessors for almost four decades.

Our work on this program, Mr. Chairman, has brought to light a number of issues and problems which I will outline for you. However, it is also clear to us that the Department has achieved a number of successes and is committed to improving the organizations and operations of the EM program.

Study on Risk Based Approach. In September of 1993, the Department of Energy sought advice from the National Research Council on whether a risk-based approach for evaluating the consequences of alternative waste management actions in the Department was feasible and desirable. The NRC appointed Dr. Frank Parker, Distinguished Professor of Environmental and Water Resources Engineering of Vanderbilt University, to lead a group of experts in risk assessment and other related fields. Besides the fourteen committee members and the twenty seven workshop participants representing stakeholders in the DOE Environmental Management program, there were hundreds of other interested persons participating in the committee's information-gathering workshop and thousands connected through satellite hook-ups at over 300 sites. The committee found that the use of risk assessment as one of the tools in priority-setting was feasible and advisable. An important further finding, captured in the name of the report, *Building*

Consensus Through Risk Assessment and Management, was that with rigorous, consistent, and continuous inclusion of stakeholder groups in the effort, risk assessment can become an important element of consensus-building for key decisions in the remediation of DOE sites. Through this consensus-building process and perhaps through a new organizational setting for risk assessment, the credibility of DOE can be improved. I am pleased to say that the recommendations of the report were embraced by the Department and became the central themes for the incorporation of risk assessment as a decision-making tool in the cleanup of DOE sites.

Study of EM Program. In April of last year, at the request of Thomas Grumbly, who was then Assistant Secretary for Environmental Management at DOE, the Academy began a project focused on a re-engineering of systems in the EM program and a re-examination of the scientific, engineering, and institutional barriers to achieving cost-effective and safe stewardship of the Department's resources. Four subcommittees were assigned the following topics:

- Evaluation of regulatory measures.
- Setting priorities, timing, and staging.
- Utilization of science, engineering, and technology.
- Organization and Management.

. A total of 43 committee members participated in four workshops with 54 participants from outside the committee. A Synthesis Subcommittee was formed and my testimony on this report is drawn largely from its conclusions.

The Synthesis Subcommittee believes that several Department initiatives are particularly deserving of mention and praise:

- The recently announced research and development initiative aimed at bringing the Department's and others' basic-research capabilities to bear on the problem.

- The introduction of a performance-based integrated contract that includes the elements of a Department contract-reform initiative.

- The integration of risk and long-term cost data into the budgeting process.

- A substantial and effective effort to improve stakeholder participation.

A number of themes run throughout the four subcommittee reports. The first is the observation that the Department has undertaken a long-term task. Nonetheless, there is a consensus among regulators, the Department, Congress, and the public that it is time to get on with the task of cleaning up the nuclear weapons complex.

Responsible Stewardship

All stakeholders and the Department wish to bring the Program to a point where it is producing results as quickly as possible. Environmental management should use the concept, *responsible stewardship*, which means undertaking appropriate near-term or midterm action to remediate a site to protect the public and the environment when a permanent solution is not at hand. Communities and states that are willing to make institutional commitments to implement such plans for near-term and midterm remedies are participating in responsible stewardship. In the absence of permanent solutions, responsible stewardship allows progress to be made by providing adequate protection against environmental and human-health risks that are serious and long-lived. It deals with waste in relatively short periods—say, 20 years. After such a period, approaches should be re-examined, and society can decide what to do for the next 20 years. Until permanent solutions are developed, irreversible actions should be avoided.

Land-Use Planning

Effects on land use and groundwater should be among the first considerations in the planning of remediation. There is also a need for a formal decision-making framework for future land-use and cleanup standards. The framework must include an opportunity for stakeholder input at all stages and lead to enforceable but modifiable agreements as further knowledge is gained.

Incentives, Metrics, and Accountability

In the short term, an effort to improve incentives, metrics, and accountability of federal employees and contractors would be the most effective way to improve the performance of the Environmental Management Program in meeting its goals, lowering its costs, and improving its safety. Disincentives in the Environmental Management Program must also be identified. Internal operations and the integration of science, technology, and engineering into the implementation of the goals of the Program are hampered by conflicting incentives that are unstated but understood by employees. It is necessary for the unstated golas, such as providing continued employment and funding for a site, to be recognized and incentives changed to are hampered by conflicting incentives that are unstated but understood by employees. It is necessary for the unstated goals, such as providing continued support the stated goals of the organization; otherwise, employees will have conflicting incentives that undermine management objectives.

A fundamental disincentive in the Department is that programmatic groups (e.g., those related to defense programs and fossil energy) do not budget for the management and disposal of the wastes that they generate. The Environmental Management Program provides the service and funding for that. Having the Department's various programs "pay" Environmental Management for the services would provide an incentive for the programmatic groups to minimize waste and use appropriate technology.

The Department is to be congratulated for moving toward performance-based contracts. More should and can be done. A further step would be to place more financial and regulatory risk in the private sector. Environmental Management has proposed "privatization" of some of its activities in this way. In general, it should use private-sector models and privatization to meet its objective. However, the models must be carefully adapted to suit the public-sector mandates.

There is room for improvement in the Department's operations. It is possible to create a civil-service program that provides more incentives for performance. The Department needs more technically knowledgeable people, including people trained in public health, who are able to judge contractors' cost estimates in the context of what the work is intended to accomplish. Also, as the Department goes to more performance-based contracting, the lines of authority in the field will become blurred, compared with the previous practice of cost-reimbursal contracting through field offices. Environmental Management should administer all the contracts that it lets. A key to achieving changes in the operation of the Environmental Management Program will be clear leadership from the Secretary.

Establishing a System for Setting Priorities

Any priority-setting system and its attendant tools must be placed in an overall organizational framework to be effective. Congress usually specifies the missions of an agency in the legislation that defines its programs and activities. The Department has several missions, and environmental management is integral to all of them. The vision provides the agency, its staff, and the public an integrated look at the organization's future state.

Goals are specific targets for components within the vision: what specifically is the organization trying to achieve in the short term and long term? Objectives are short-term and generally quantifiable measures of accomplishment in pursuit of the agency's goals, missions, and vision. Goals can pertain to many facilities or activities; objectives often pertain to single facilities or activities. The success of a priority-setting system depends on how well it is implemented. The Department needs to develop performance standards and metrics to measure as quantitatively as possible its performance and progress.

The Environmental Management Program appears to understand its mission, and this is becoming apparent to those outside the Department. The Department needs to set specific goals. These goals include target cleanup levels, magnitudes of occupational risk to be tolerated, end uses of former Department facilities, and the role of repositories in the overall program.

Risk Assessment and Cost-Benefit Analysis

Risk assessment, cost-benefit analysis, and other tools used in priority-setting are necessary for managers and stakeholders to use in making decisions. They are only as good as the information they are based on. Ultimately, many factors outside those data-driven tools can affect the decision-maker. The priority-setting process should be able to identify the locations and situations that pose the most serious risks to the public, to workers at Department sites, and to the environment. Imminent serious health and environmental risks should have the highest priority for action.

Science and Technology

Science and technology play key roles in virtually all activities of Environmental Management and are vital for improving the performance and safety of the Department in the longer term. The Department must dramatically improve its research and technology-development outreach. That can be accomplished only by widely opening its research and development program to all qualified persons and organizations, regardless of type or location. Concomitantly with opening the Environmental Management Program R&D procurement system, a broad-based system of external peer review must be carefully implemented and monitored to ensure that the best proposals are selected.

The decision as to whether National Laboratories, universities, or industry should take the lead in a basic-research effort or in the development of any particular technology should be based on a competitive process that undergoes external review, not on a formula or some other form of entitlement. Teaming together and partnering these different groups is often the most-effective approach. National Laboratories constitute an extraordinary technical resource both in capability and in size. It must be recognized, however, that the Laboratories are unique in culture and expertise (especially with nuclear materials); this can be both an advantage and a disadvantage in bringing new technologies and science to bear in the Environmental Management Program's activities.

Regulatory Measures

The Department is subject to external regulation and in some respects is self-regulating. Regulatory systems in which entities regulate themselves lack credibility. Given the magnitude of the risks associated with manufacturing and maintaining the nuclear weapons stockpile, effective and credible external regulatory programs are necessary. The Department's self-regulation of its nuclear-related activities should be eliminated and an appropriate outside agency found to carry out these responsibilities.

In a number of instances in which the Department and its contractors cite regulatory restrictions as prohibiting common sense and safe solutions to their challenges, there is usually some form of regulatory flexibility that has not been applied. Industry often works with regulators to find mutually acceptable compromises in the face of regulatory requirements. The Department should encourage the Environmental Management Program and its contractors to use the available flexibility.

The current regulatory system is a confusing patchwork assembled, at least in part, with the special circumstances of weapons production in mind. A number of potential problems are caused when the authorities of multiple regulators—such as states, the Defense Nuclear Facilities Safety Board, and the Environmental Protection Agency (and sometimes the Department)—for cleanup of a given site or operable unit overlap. If more than one regulatory entity has jurisdiction over a Departmental site, a lead regulator should be designated for a given operable unit. A lead regulator should be appointed for each treatment, storage, and disposal facility. The lead regulator should oversee all day-to-day compliance or cleanup actions and decisions and should resolve disputes. Other regulators on a site should recognize and defer to the authority of the lead agency. The mechanism for achieving this goal could be its incorporation into existing compliance agreements.

Public Participation: Searching for Consensus to Achieve Credibility

The call for all Departmental efforts to be open and transparent to stakeholders recurred throughout the work of this committee's four subcommittees. The committee has said that involving stakeholders is crucial for creating workable consensus, whether the issue is the decision process for technology selection or the performance of a risk assessment for remedial-action options, the Department operates in a political environment in which citizen support is essential to obtain funding and, in many cases, to avoid costly and protracted litigation or similar consequences. Consensus is the key to credibility in this political environment. Without credibility, little will be accomplished by the Environmental Management Program in realizing its vision or satisfying its mission.

Risk assessment, cost-benefit analysis, and other tools used in priority-setting are necessary for managers and stakeholders to use in making decisions. They are only as good as the information on which they are based. Ultimately, many factors outside those data-driven tools can affect the decision-maker. The priority-setting process should be able to identify the locations and situations that pose the most serious risks to the public, to workers at Department sites, and to the environment. Imminent serious health and environmental risks should have the highest priority for action. For non-imminent risks, risk assessment should identify the benefits of risk reduction as part of overall cost-benefit analyses, which should form the basis of further priority-setting and resolution of contamination problems that must be addressed as required by law or compliance agreements.

BOARD ON RADIOACTIVE WASTE MANAGEMENT

Much of the National Research Council's work for the Department of Energy-Office of Environmental Management is managed by the Board on Radioactive Waste Management (BRWM). The BRWM was organized in 1958, and its mission is to survey the needs, review plans, recommend programs, and provide analytical advice on all aspects of the management of radioactive and mixed wastes in order to protect public health and the environment. Under this Board, we have a number of committees focused on particular aspects of the Environmental Management Program. These are

Committee on Environmental Management Technologies. The Committee on Environmental Management Technologies was formed in 1994 to provide the Department of Energy-Office of Environmental Management with continuing independent reviews of the development and use of technology for cleanup of the weapons complex. The committee and its subcommittees provide advice to the DOE in five focus areas: (1) contaminant plume containment and remediation; (2) landfill stabilization; (3) high-level radioactive waste tank remediation; (4) mixed waste characterization, treatment, and disposal; and (5) facility transitioning, decommissioning, and final disposition. To date, the committee has published two reviews covering the periods 1994 and 1995.

In its 1994 review, the committee concluded that the DOE-EM program approach based on focus areas and cross-cutting technologies is a promising one. The committee's 1995 review recommends a number of steps to strengthen the program. These include:

-development and implementation of quantitative criteria by which technology-development efforts can be prioritized and success can be measured;

-careful consideration of waste streams in determining technology-development needs;

-assessment and documentation of efforts to develop and apply technologies using the quantitative criteria mentioned above; application of effective peer review in the selection, evaluation, and prioritization of projects; and improvement of the system for information gathering and documentation on technologies that are available or under development by other relevant organizations in the U.S. and abroad.

Committee on Remediation of Buried and Tank Wastes. The Committee on Buried and Tanks Wastes was organized in 1992 to review and evaluate plans and actions by the Department of Energy (DOE) to remediate buried and tank-contaminated defense radioactive wastes at the Idaho National Engineering Laboratory, Hanford Reservation, and other relevant DOE sites and facilities that make up the nuclear weapons complex. Its work complements the activities of the Committee on Environmental Management Technologies, which focuses exclusively on technology development.

During the past two years, the Committee on Buried and Tank Wastes has published three reports that deal with a wide range of cleanup problems in the weapons complex:

The Potential Role of Containment-in-Place in an Integrated Approach to the Hanford Reservation Site Environmental Remediation (published February, 1996). Barriers for confinement-in-place of buried waste have been used effectively in many environmental remediation activities. Numerous sites contaminated by buried or tank-stored radioactive waste, such as the Hanford Reservation, will probably require some form of containment-in-place during their lifetimes. This report recommends that containment-in-place technology be considered and evaluated on its technical, fiscal, environmental, and pubic health merits as a possible short- to long-term alternative to waste removal on a site-by-site basis.

Barriers to Science: Technical Management of the Department of Energy Environmental Remediation Program (published January, 1996). This report identifies and comments quite candidly on several problems related to management of ongoing cleanup efforts in the weapons complex. This report notes that environmental management activities are driven too often by the internal needs of the organizations charged with the remediation work rather than by the overall goal of environmental remediation.

Safety of the High-Level Uranium Ore Residues at the Niagara Falls Storage Site, Lewiston, New York (published December, 1995). This report reviews and evaluates past, present, and planned future handling and storage of the Niagara Falls Storage Site (NFSS) high-level radioactive residues. The report concludes that there is no immediate hazard to the off-site public from these residues in their present configuration, but that these residues do pose a potential longer-term risk to the public if they are left permanently at the NFSS. The report recommends that a program be developed by the DOE for removal, treatment, and off-site disposal of the NFSS high-level residues. The report also recommends that a monitoring strategy be developed to measure and track radiological and chemical contaminants from the NFSS waste containment structure both prior to and following removal of these residues.

Committee on Separations Technology and Transmutation Systems. The Committee on Separations Technology and Transmutation Systems was convened at the request of the Secretary of Energy to evaluate the relative effects, costs, and feasibility of employing separations and transmutations technologies in the Department of Energy's programs for managing spent nuclear fuel from nuclear reactors and radioactive wastes in tanks at selected sites. The principal findings and recommendations of the committee's report, *Nuclear Wastes: Technologies for Separations and Transmutation*, are the following:

-None of the separations and transmutation system concepts reviewed by the committee eliminates the need for a geologic repository. DOE should continue to develop a geologic repository for spent fuel.

-The current policy of using the once-through fuel cycle for commercial reactors, with disposal of spent fuel as high-level waste, should be continued.

-Fuel retrievability should be extended to a reasonable time (on the order of 100 years) to avoid foreclosing alternative fuel strategies that may be in the national interest.

-Research and development should be conducted on selected topics to support the cost-effective future application of separations and transmutation of commercial spent fuel and separations for defense waste applications.

Building an Environmental Management Science Program. The Department of Energy has established a long-term, environmental management science research program to support the development of new and improved characterization, remediation, and disposal technologies. At the request of Thomas P. Grumbly, the acting Under Secretary for Energy, a National Research Council committee is being formed to advise the Department of Energy on this program.

DECONTAMINATION AND DECOMMISSIONING

Finally, Mr. Chairman, our Board on Energy and Environmental Systems undertook a study on reducing costs for decontamination and decommissioning, a study requested by the Energy Policy Act of 1992. The Board made a thorough study of the uranium enrichment facilities throughout the DOE complex, and made several recommendations, including:

-that this effort for the three gaseous diffusion plants is essentially a large deconstruction project that can be effectively undertaken in the near term.

-based on experience with other D&D projects, previous cost estimate to carry out the three plant are too high, and there are opportunities for major cost reductions, and

-three proven technologies are available for cost-effective D&D of these plants.

As you can see, Mr. Chairman, the NRC has a high degree of familiarity with many aspects of the EM program. The program faces enormous challenges and problems, but progress is being made, and the Department deserves high marks for subjecting its efforts to outside, independent reviews. We have found them to be very responsive to NRC suggestions.

Thank you for the opportunity to testify, and I would be pleased to answer any questions you may have.

Chairman ROHRABACHER. Thank you, Dr. Colglazier.

I have a few questions and then we will move on to the rest of the members of the Committee.

First of all for Ms. Steinhardt. Could you tell me the difference between a plume and a tailing. What are we talking about here, plumes and tailings?

Ms. STEINHARDT. Solids and liquids I think largely. The tailings are residues left over from the processing of ores. It's a sand-like material. A plume is usually, and I will turn to the scientists on the panel for greater clarification here——

Admiral GUIMOND. If you would like, I would be glad to help.

Chairman ROHRABACHER. Sure.

Admiral GUIMOND. Under many sites, whether it be a mill tailings pile or other areas, if you have groundwater underneath it, you can have the contaminants, whether they're radioactive or hazardous, go down as rain comes down into the groundwater. As the groundwater moves under a particular site it carries that contamination with it. So as that contamination goes it spreads out underground, similar to if you——

Chairman ROHRABACHER. That's a plume?

Admiral GUIMOND. That's a plume.

Chairman ROHRABACHER. Now a plume is dealing with the groundwater?

Admiral GUIMOND. Correct.

Ms. STEINHARDT. Correct.

Admiral GUIMOND. And under the ground it spreads out similar to like if you look at a coal-fired power plant, you seem a steam plume coming off the top, and it's similar underground.

Now a tailing, as Ms. Steinhardt said, is basically the solid materials, the sandy-type materials which are the solid pile if you will on the top of the ground.

Chairman ROHRABACHER. It's on the top of the ground and it's not underground concentrated in different areas under the ground.

Ms. STEINHARDT. It's disposed of.

Admiral GUIMOND. It's disposed of and eventually covered up. So it's underground. But usually these are piled up on the top of the ground.

Chairman ROHRABACHER. It seemed like you were saying, Mr. Steinhardt, that there was a great deal of cost overruns that you were analyzing for us in the past in dealing with these problems. Quite frankly, it is a bit overwhelming after listening to your testimony in talking about the hundreds of millions of dollars of overruns that we've faced in the past. Do you think there is something that could have been done then that would have prevented these overruns?

Ms. STEINHARDT. Well I think part of the overruns were just caused by events that DOE couldn't foresee, like new EPA regulations that were developed once the cleanup effort was underway, the new transportation requirements and so on. So that accounts for part of it.

We didn't look at the overall management of the program. I know that there were some concerns on the part of the States who had to pay a share of those costs even though they weren't running the program. There were some concerns about how well the programs were managed, especially the contractor oversight.

Chairman ROHRABACHER. So perhaps it's not just changing the rules, but it could have been bad management as well.

Ms. STEINHARDT. It could have been, yes.

Chairman ROHRABACHER. Well we're going to make sure we keep our eyes open and make sure that doesn't happen. We are talking about hundreds of millions of dollars worth of taxpayers' money here.

Ms. STEINHARDT. And billions overall.

Chairman ROHRABACHER. Yes. It was just staggering to listen to your testimony.

Mr. Brush, what criteria does the DOE use to decide whether a project is funded from the defense side or the non-defense side? Some of the labs, Los Alamos, Sandia and Livermore laboratories are all primarily defense labs, and yet the overwhelming amount of money for their funding for safety and health comes from the non-defense budget. So why is that and what is the criteria that DOE uses?

Mr. BRUSH. Let me try to answer the two points to that question, Mr. Chairman.

The first one you've rightly pointed out, that our budget presentation this year is a new format. We've tried to break it down between those activities that are principally devoted to the defense and the non-defense sectors of the work that we do.

We as a corporate ES&H, Environment, Safety and Health Office for the Department, we can't make those distinctions based on strict accounting because, for example, if we're writing a policy on radiation protection that applies to all of the Department of Energy, I can't tell you how much of that expense is devoted to protecting people at Los Alamos as opposed to how much of it is devoted to protecting workers say at Brookhaven National Lab.

So we try working, by the way, in consultation with the staffs of the appropriate committees to come up with a presentation that makes the most sense possible. We have taken that work which is principally directed toward work at the sites that are devoted to the weapons program, for example, the oversight work, and put that in the defense column, and we have picked things like these science studies that we do that apply broadly to our activities and to activities in general and put them in the non-defense side. I would simply say this is an art and not a science that we've accomplished in redefining our budget.

Turning to your second question, which is the apparent inconsistency between the amount of money we're spending for non-defense work with the defense labs, I think it's important to point out that this is not money which is being spent by the labs for their own programs. This is money that we are using to buy the services of the laboratories to conduct work throughout the Department of Energy complex.

For example, if we need a plutonium criticality expert to help us with work generically across the Department, we will buy those services from a place like Los Alamos National Lab, but it will have benefits for the entire Department of Energy complex. I hope that attempts to answer your question.

Chairman ROHRABACHER. Yes, thank you.

I'm going to yield the balance of my time to Mr. Wamp.

Mr. WAMP. Thank you, Mr. Chairman. I appreciate you accommodating my schedule.

Dr. Brush and Admiral Guimond, a couple of questions just for the record.

As a Member of the Speaker's Task Force on Nuclear Cleanup, one of our concerns here is that this country needs to establish de minimus levels in non-defense environmental programs, particularly K-25 at Oak Ridge which I'm very familiar with.

As we seek to reindustrialize that facility, why is it so difficult in this country, unlike other industrialized countries, to establish de minimus levels of cleanup so that we can begin to try to make some progress so the taxpayers will have more confidence in our environmental management efforts so that we can turn some of these facilities around?

From your perspective, either of you, why is it so difficult here to establish a de minimis level, you know, an acceptable health and safety risk? Like we're trying to melt some metal out of some of the facilities in Oak Ridge and then sell that metal domestically or internationally, but we can't do that. Why?

Admiral GUIMOND. Well you've hit on what has been obviously a very controversial issue for a number of years dealing not only with materials that the Department of Energy has got, but a variety of other people that may have nuclear materials.

Prior to the current assignment I have, I ran the radiation program, for example, at the Environmental Protection Agency, and in 1988 we made an effort to come through with a presentation of what we called a de minimus standard, if you will, and quite candidly at that time there was a lot of disagreement from other Federal agencies, from public sector groups, from environmental groups and from groups on frankly both sides of the issue.

Some believed the numbers should be higher and some believed they should be a lot lower, and it has been difficult to get sufficient consensus from EPA's standpoint that would be in charge of issuing many of these types of regulations to be able to move forward. We are now engaging EPA in appropriate discussion, and we are optimistic that significant progress will be made in the future.

Mr. WAMP. A follow-up question. The overall DOE Environmental Management Programs are really carefully scrutinized and overlap somewhat with state programs and EPA programs. There is this shared jurisdiction in the State of Tennessee and they do cooperate reasonably effectively. But in your Environmental Management Programs, particularly the ES&H accounts, it seems like there is a lot of dual jurisdiction, technical assistance guidance and interpretation of regulations from one to another.

Just how much bureaucracy exists within these programs honestly as we look at the amount of funding that you'll need for 1997?

Mr. BRUSH. I think the answer is that our restructured program for oversight and technical assistance and policy should eliminate and reduce any of the overlaps that formerly existed.

When the Secretary realigned the Department, one of her major goals was to eliminate overarching and redundant layers of oversight. Those have been eliminated now, and the Office of Environment, Safety and Health is the exclusive office conducting independent oversight for the Department. Likewise, within our own Office of Environment, Safety and Health, we have taken five offices that were writing safety and health policy and combined them into a single office with savings there as well.

We're very mindful of that problem, and we think we've taken steps to substantially save money in that area, and you can see it in our budget request.

Chairman ROHRABACHER. Zach, you have time for one more question.

Mr. WAMP. That closing statement is what I was looking for. Thank you, Mr. Chairman.

Chairman ROHRABACHER. Mr. Roemer, would you like to proceed.

Mr. ROEMER. Mr. Chairman, I would like to reserve my opportunity to ask some questions, but in terms of accommodating a Member's schedule, I would like to ask that Ms. Jackson Lee from the State of Texas be recognized for the first 5 minutes on our side.

Chairman ROHRABACHER. Certainly. With no objection you may proceed.

Ms. JACKSON LEE. I want to thank the Ranking Member very much. I appreciate his kindness, and I probably will not have a lengthy questioning.

Mr. Chairman, I thank you for this hearing that we obviously needed to have, and I would ask unanimous consent to allow me to submit an opening statement within the time period that you allow.

Chairman ROHRABACHER. Certainly. Without objection.

Ms. JACKSON LEE. Thank you very much.

Let me acknowledge, first of all, that I think the business of this particular hearing is extremely important as it relates to radioactive cleanup and certainly monitoring of some of these issues around our citizenry who have mentioned their concerns as well.

I would like to go directly to Mr. Brush on the question of the Department's recent government-wide look at what we call environmental justice issues, particularly as it relates to minority and disadvantaged populations' proximity to nuclear contaminated sites.

I understand that either the DOE has proceeded with an overview study or has concluded one, and I would like to get a summarization of that with respect to where the Department stands on that issue, and as well if I can get projected, I may have the numbers in front of me, and I apologize if I have not looked at them, just the long-term cost and how long we will have to continue in some of these efforts dealing with this radiation question.

My last point, which I'll just simply make, and if someone wants to step away from the purpose of this hearing and answer the increased costs of gas at the gas station, I'll take that answer as well, but maybe no one wants to jump into that, but I hope that you will recognize the concern we have on that issue, and I understand the Department of Energy is certainly involved in the review of that. I would only argue that review now rather than later would be very important to our constituents.

But if you would answer the question dealing with the environmental justice point I would appreciate it.

Mr. BRUSH. Perhaps both of us can contribute to the answer.

Ms. JACKSON LEE. Thank you.

Mr. BRUSH. I thank you for that question. We have been working with the other government agencies involved with environmental justice, and let me give an overview. It is a particularly important issue for the Department of Energy.

As I indicated in my opening statement, we face unique hazards around the Department of Energy sites. These are hazards that are not faced by other industries and other agencies stemming from the unique nature of the work that has been done in the past, and we are very concerned that as we move toward putting in place safety and cleanup programs for these, that we respect the tenets of environmental justice that are part of the work that is ongoing within the Administration. We have been working with not only participants within the Administration, but outside the Administration as well to address those points at all of our sites.

Admiral GUIMOND. Let me add a couple of things. I have the program that is in charge of the cleanup at a number of the particular sites, and what the Department has been doing is we have an Environmental Justice Coordinator that works in one of the staff offices to the Secretary, but each of the specific program offices, in my particular case, Environmental Management, also has an Environmental Justice Program within it.

I'll give you a few examples of some of the things we've been doing to try to address this. We have been doing a significant amount of outreach to bring into the dialogue at our sites relative to what the goals envisioned for cleanup should be and what the specific concerns of various groups are.

At many of our sites, for example, we either have a significant number of Native Americans or Hispanics in particular. So we have created site-specific advisory boards, we have included people from the communities to represent them on those. For example, at Savannah River in South Carolina we have a number of groups representing folks with a number of environmental justice concerns down there in those areas.

So we believe that we've got a very active program that has engaged people bringing them into the dialogue as to what should be done, and if there are any perceived inequities, then what is the right way for us to deal with those.

Ms. JACKSON LEE. If I might just to conclude, in all of that——

Mr. ROEMER. Before the gentlelady concludes, could I just ask her to yield to me for 30 seconds?

Ms. JACKSON LEE. I would be delighted.

Mr. ROEMER. I would just underscore the gentlelady's questioning. I know that you talked about this in your opening remarks, Mr. Brush, but this is question that the gentlelady from Texas asked that had implications, as you know, all over the United States. I have a community in Michigan City that has been very seriously and adversely affected by this, and I would like to associate with the gentlelady's remarks and concerns for this.

Ms. JACKSON LEE. And with that I would simply say maybe you would provide the Ranking Member and myself with some additional information.

My last question is simply to say you are working, I hope, extremely hard to contain those areas and are particularly sensitive in your cleanup with respect to the surrounding populations.

Mr. BRUSH. Yes, we are, and very sensitive, for example, to the particular values that the surrounding populations may have on how that cleanup would go, and those are variable depending upon whether you maybe have a significant amount of African Americans in the region or Hispanics or Native Americans, and we're trying to factor their specific concerns into it.

Ms. JACKSON LEE. Let me thank the Ranking Member and the Chairman, and if I have any time I'll yield it back.

Thank you very much.

Chairman ROHRABACHER. Well thank you, and we will now turn to Mr. Roemer for his period to question.

Mr. ROEMER. Thank you, Mr. Chairman.

Mr. Brush, I would like to get into what I remarked briefly on in my opening comments, and that was my bill H.R. 1510 to require that DOE facilities move more quickly toward external regulation.

As you know, I feel and many other Members of Congress feel that there are layers of bureaucracy now that are duplicative and we think wasteful that would save the taxpayers a lot of money if we move toward external regulation.

I understand that back in January, the Advisory Committee on External Regulation recommended to the Department that you move toward external regulation of your facilities. Can you summarize what the Department is doing to respond to this recommendation, and also could you quantify the cost savings as well, too.

Mr. BRUSH. Let me summarize by going back even further than January. As many members of the Committee know, the Department of Energy is self-regulating in a number of areas—it's important to remember that not all areas. The Department is externally regulated in its environmental activities as we've been discussing this morning; but in particular areas of nuclear safety and the like, the Department is self-regulating.

This problem was directly addressed by the Secretary early in her tenure, first with respect to the fact that we are self-regulating with respect to occupational safety and health, that is many of the Department's activities, nuclear activities are not subject to regulation by the Federal Occupational Safety and Health Administration, and then moving beyond that to the issue of external regulation of nuclear safety. The Department is not currently regulated for most of its activities by the Nuclear Regulatory Commission.

In response to that, the Secretary established the Advisory Committee on External Regulation of DOE Nuclear Safety headed by Mr. John Ahearn, and that report was released in December. It recommended that the Department should be externally regulated for most of its nuclear activities. There were some minor areas excluded, but the vast majority would be affected by this recommendation.

The recommendation was in general accepted by the Secretary, and in response she has put in place an internal process headed by Acting Under Secretary Tom Grumbly whose charge is to come forward by the end of July with an implementation plan to carry out those recommendations.

The basic areas that are being investigated of course include some of the areas that are most interesting perhaps from the general public's standpoint, which would be the question of which existing Federal agency should be given that job or should a new agency be created.

I would like to underscore as part of my answer that some of the problems that we have to address, although perhaps not as interesting publicly, are vital to ensuring safety of Departmental operations.

Two that I would single out would be, first, that under any system of external regulation there needs to be a strong, internal corporate function that provides to the Department's leadership some ability to monitor and oversee how safety of DOE operations are ongoing. As a CEO of a large corporation, you don't want to wait until the regulator comes and cites you for a violation before you are able to take steps to fix the problems. So the need for a strong internal function has been recognized by the Advisory Committee and is essential.

The second point I would like to make is that whenever you are transitioning to a new system of regulation, such as we're talking about here, that transition itself brings to the fore potentially serious safety problems that must be addressed. When we know that if we're going to transition to a new system we have to keep in place a very aggressive and very attentive program to ensure that the safety initiatives we have underway are not lost in the process of transitioning to a new system.

As to your question on cost, I cannot give you that number now. That number has been requested as part of the study that Acting Under Secretary Grumbly has committed to complete by the end of July, and we will of course provide that to you as soon as we have it.

Mr. ROEMER. I would appreciate that. What kind of time frame would that be on, Mr. Brush?

Mr. BRUSH. The Secretary has commissioned this study by the end of July.

Mr. ROEMER. Now usually when we hear about this you couple the defense and the civilian side of whether or not we can move toward external regulations. If we decoupled these efforts could we move more expeditiously on the civilian side and save more money?

Mr. BRUSH. That's a good question and it's one that the Under Secretary's group is looking at. I would only caution that so many of DOE's activities are multi-purpose in nature that it would be much like the Chairman's question about how we break our budgets down into defense and non-defense. It's going to be very difficult to determine how exactly to draw the line.

Mr. ROEMER. I would just caution you back, too, in terms of your answer to the external regulations, that we don't try to, with your caveats on internal regulations that need to be set up to give warning on upcoming problems and in-transition costs, that we don't whittle away all the savings with those two components taking up too much of where we're trying to move in terms of new ideas and more progressive ideas.

I thank the Chairman.

Chairman ROHRABACHER. Mr. Doyle.

Mr. DOYLE. Thank you, Mr. Chairman.

Dr. Colglazier, just one question. In your testimony you've recommended that the Department enhance the long-term research on environmental management problems, and it's my understanding that DOE now has an effort underway to provide approximately $50 million for such research. They've earmarked $20 million for university research, $20 million for DOE laboratory research and $10 million for integrative research.

You've also said in your testimony that you don't believe DOE should earmark such research monies for specific types of research performers. Do you agree with the manner in which DOE has set up this program and are you satisfied with its plans to complete proposals?

Dr. COLGLAZIER. First of all, we applaud very much the fact the Department is creating this basic research program for the environmental cleanup effort. We think it is needed.

The Department has also asked the Academy to set up a committee to review how they're implementing it this year and to make recommendations for future years. That committee actually will have its first meeting in two weeks. So we will have our first report later in June and subsequent reports later this fall. So we will certainly be reporting back to you on our view, but overall we're certainly glad the initiative has been started.

Mr. DOYLE. Thank you.

Admiral, maybe you could answer this question. Where else in DOE is environmental research and development taking place, and how can we best use those assets in a coordinated fashion to meet the overall mission?

Admiral GUIMOND. There is some environmental research that occurs throughout the Energy Research Program, which is a large multi-billion dollar research effort that occurs in many of the national laboratories throughout America; and in addition to that, those national laboratories in many cases may conduct some environmental-related research that is funded, not by the Department of Energy, but in fact may be funded by the Department of Defense or the National Institutes of Health or other groups that have a bearing here. Some related stuff is done by, for example, the Office of Fossil Fuels, who are focused on fossil energy type of stuff, will conduct some activities in the environmental arena, too. Those are a few examples.

Mr. DOYLE. Thank you very much.

Mr. Chairman, I yield back my time.

Chairman ROHRABACHER. Thank you, Mr. Doyle.

I have one more question for Mr. Brush. You mentioned the Japanese and this Radiation Effects Research Foundation that has been examining the health of families from atomic bomb survivors. How much money is being put into that?

Mr. BRUSH. Currently we are spending approximately $20 million a year. As I indicated, this is a joint program between the United States and the government of Japan. We are working very hard with the government of Japan to reduce those costs.

Last year as part of our budget process the Congress directed us to find ways to save money in that program. We have reduced our budget request down to $15 million for 1997.

Chairman ROHRABACHER. From 20?

Mr. BRUSH. From 20, a 25 percent savings.

Chairman ROHRABACHER. And when do you expect that this program will be no longer in existence?

Mr. BRUSH. Let me answer that in two ways. First of all, the program that is going on now is vitally important. The research that is now underway focusing on survivors of the atomic bombings is convinced, and we agree, that the data that will be obtained by looking at the exposed populations as they enter their later years will be very important in terms of the science of radiation protection. So there is still very important science to go on there.

Chairman ROHRABACHER. Radiation protection?

Mr. BRUSH. Yes, sir, in terms of setting standards, international and national standards for radiation protection. All of the standards that exist today for protection of the public from radiation, whether it's hospitals, nuclear plants or the like, that data essentially stems from the studies that have been conducted in this Japanese work.

But your question is a very good one because obviously this work should not go on forever. We commissioned with the government of Japan last year a distinguished Blue Ribbon Panel to look at this very question, and we expect to have their report within a month or so as to their recommendations on the future of this program, and we'll be happy to share it with you.

Chairman ROHRABACHER. I thought you were going to say when the very last survivor dies we'll close up the shop.

Mr. BRUSH. Well that is of course one approach, but we are also interested in the additional generations and the subsequent generations as well.

Chairman ROHRABACHER. You know Ronald Reagan used to say that a government program is the next best thing to eternal life on this planet.

[Laughter.]

And sometimes, you know, there's always going to be some benefit there. Frankly, I do believe that studying the effects of radiation, this massive radiation that these people experienced, was certainly a benefit and the amount of information we received from it was a benefit to all of us because it was a whole new phenomena for mankind when this study began. But after 50 years I think this is something we've got to look at and figure out just how much this information will be put to use.

Perhaps just knowing, if there is a nuclear war or something or a nuclear accident, what the long-term effects are after 50 years on people would be of some benefit, but I'm not sure we have to go at this with the same level that we've been doing.

Mr. BRUSH. As I said, this is why we're cutting the budget for it.

Chairman ROHRABACHER. Yes, sir, I noted that.

Admiral GUIMOND. Mr. Chairman, if I might just comment on that from the standpoint of a program that operates facilities out there.

As Mr. Brush indicated, over the years we've learned a tremendous amount about the effects of it in causing cancer and various other kinds of things from watching these people as well as whether there are effects on their children from the standpoint of birth defects or those kinds of things, and that I think has provided a very, very excellent information to ensure that future workers at sites, such as our sites or nuclear power plants or hospitals, do not have similar kinds of radiation problems.

Chairman ROHRABACHER. But of course the people that work around nuclear material wouldn't be having the same type of effects that someone who went through a nuclear blast would be having.

Admiral GUIMOND. That's true, but they're still exposed to radiation. So you have a varying degree of radiation exposure that some of these people had. So by looking at that we get an idea about at what levels is there really a risk and what at what levels isn't there a risk.

Chairman ROHRABACHER. All right. Well thank you very much, Admiral, and thank you all. I appreciate it.

This panel is dismissed, and would the second panel move forward.

[Panel 2 on Nuclear Energy comes forward.]

This appears to be a vote, and what I'm going to do, without objection, is suggest that we come back here at 12:15 which gives us time to grab a sandwich, and then we will hear from the panel starting at 12:15. Thank you very much.

This Committee is in recess until 12:15.

[The Committee recessed to vote at 11:45 a.m., to reconvene at 12:15 p.m.]

AFTERNOON SESSION

Chairman ROHRABACHER. The hearing will come to order.

Our second panel will cover the Office of Nuclear Energy.

Dr. Terry Lash is Director of that Office and is with us today, as is Tom Schatz, President for Citizens Against Government Waste. I should pronounce his name correctly after all the times that we have spoken together and had him here to testify. Phillip Bayne is President and Chief Executive Officer of the Nuclear Energy Institute, and Matt Freedman is the Energy Policy Analyst for Public Citizen's Critical Mass Energy Project.

With that, I want to suggest that you basically keep your testimony down to about five minutes, and then you are certainly welcome to submit much longer testimony for the record. So if we could proceed with that understanding. Thank you very much.

Dr. Lash.

STATEMENT OF DR. TERRY R. LASH, DIRECTOR, OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY, U.S. DEPARTMENT OF ENERGY, WASHINGTON, DC

Dr. LASH. Thank you, Mr. Chairman. We would be happy to submit my full testimony for the record, and I'll make a short oral statement.

The Administration's fiscal year 1997 budget request for the Office of Nuclear Energy, Science and Technology is about $348 million. This represents a nine percent decrease for what was requested in fiscal year 1996. It includes all of our activities, except for the Naval Reactors Program.

My discussion today will not address the Naval Reactors Program, our International Nuclear Safety Program and our Nuclear Security Program. These will be addressed before the National Security Committee at another time. Thus, there is about $248 million of Administration request before the Subcommittee.

First, I want to stress that the Office of Nuclear Energy shares the Congressional interest and your interest, Mr. Chairman, in increasing the efficiency of government. Since August of 1993 the Office of Nuclear Energy has realigned its administrative, scientific and engineering resources to make the Office more efficient. In fact, our restructuring efforts meet or exceed the Administration's national performance review goals and the targets established by the Department under the Strategic Alignment Initiative. For instance, over the past 2½ years, Nuclear Energy has reduced headquarters staff by 44 percent. Over the same period the Office has reduced support service contracting by 64 percent.

One of the key challenges we are addressing is assuring that currently-operated nuclear power plants in the United States continue to operate safety and efficiently. More than a fifth of the U.S. electricity comes from nuclear power plants, and it is in the vital interest of this nation that these plants operate for as long as they can be operated safety and economically.

In addition, we are working with industry to assure that there is a viable domestic nuclear energy option for the United States in the next century.

Our Light Water Reactor Program is focused on two broad areas. First, in cooperation with U.S. utilities and the nuclear industry, the Department is completing the engineering work required to achieve NRC design certification of advanced light water reactors and to complete first-of-a-kind engineering for two advanced designs, and we have made significant progress in these tasks.

We expect to complete work on two advanced plant designs, the System 80 Plus, and the Advanced Boiling Water Reactor, early in fiscal year 1997, with a third following in fiscal year 1998, which is the AP-600. These standardized designs will provide enhanced safety, improved economy and greater reliability over existing plants.

Additionally, the Department's cooperative agreement with industry provides for the Federal Government potentially to recoup its costs on the first-of-a-kind engineering program based on future sales of nuclear power plants or the licensing of advanced light water reactor technology.

The second broad area of our program on light water reactors concerns the safe operation of existing nuclear power plants or activities or events that could cause a premature shutdown for economic reasons. This program will become in fact increasingly important to the Department in future years.

While the level of funding the Administration has requested for the Light Water Reactor Program is modest, it does enable the United States Government to participate effectively with industry in assuring that this country maintains the capability to service and build economic and safe nuclear power plants.

Without effective government involvement it is likely that the erosion of our domestic nuclear infrastructure would accelerate and the safety and economic viability of 22 percent of U.S. electricity generating capacity would be more threatened.

The Department believes that light water reactor R&D activity transcends its importance as a domestic energy issue. The export of U.S. technology, which reflects very high standards for safety, enhances the safety of nuclear power in other countries, particularly those with emerging economies, and provides financial benefits to our economy.

Many of the government's nonproliferation, foreign trade, nuclear safety and other priority interests benefit from our Light Water Reactor Program. Our nuclear technology research and development activities focus on the development of electrometallurgical technology at the Argonne National Laboratory for the treatment of the Department of Energy's own spent nuclear fuel. This treatment technology potential could save the Federal Government millions of dollars in spent fuel disposal costs. It is also being considered as a potential means of disposing some surplus weapons plutonium.

We are now completing a power plants environmental assessment for a proposed demonstration of this important technology using the sodium-bonded fuel that is being removed, or has been removed from the experimental breeder reactor in Idaho.

We will continue producing and distributing critical isotopes in fiscal year 1997. DOE-produced isotopes are sold to health care providers, researchers and industry, and they are used to diagnose and treat many illnesses and in numerous industrial applications.

We are working with the private sector to identify new approaches for reducing the government's involvement in the isotope business, and we are currently evaluating concepts suggested by the private sector and will start to work on these most promising concepts within the next six months.

An important aspect of the Isotopes Program is the effort to establish a domestic production source for the most important medical isotope in the United States, Molybdenum-99. This isotope is used about 36,000 times in the United States every single day to diagnose cancer and other illnesses, and the only supply available to the nation's health care system is an increasingly unreliable reactor in Canada.

The Department believes that this project is critical to the future availability of Molybdenum-99 in the United States. We have recently completed an environmental impact statement to develop a domestic production source and expect to issue a record of decision in June.

The Administration in our fiscal year 1997 request did not make a specific request for this project. However, depending upon the conclusions of the record of decision, the Department expects to propose reallocation of the required funds from within the Department's proposed budget.

Another key area I would like to mention today is the University Nuclear Science and Reactor Program. This program helps advance nuclear science education and research in the United States by supporting outstanding students and the effective operation of university research reactors. Most of the funds in our request will be used to provide replacement fuel, remove spent fuel and assist with important facility upgrades.

We believe that the future of U.S. capabilities in the nuclear sciences, including the production of radioactive isotopes, the analysis of new materials and many areas of research depend on the continuation of nuclear education programs around the country. Our support is vital to the continuation of many of these programs and the research facilities they operate.

We have established an effective partnership with the electric utility industry that provides research and fellowship grants to universities that receive similar commitments from utilities. We expect to fund $800,000 in grants in fiscal year 1997 which will be matched by participating utilities for a total program of $1.6 million.

Lastly, I mention the radioisotope thermoelectric generators manufactured by the Office of Nuclear Energy, and they used to power U.S. spacecraft, including the Galileo spacecraft currently orbiting Jupiter, and the Cassini mission to Jupiter which will be launched in 1997. These devices are also used by some of our national security agencies.

Thank you again for the opportunity to be here, Mr. Chairman. I would be happy to answer any questions that you may have later.

Chairman ROHRABACHER. Thank you, Dr. Lash.

[The prepared statement of Dr. Lash follows:]

STATEMENT OF
DR. TERRY R. LASH, DIRECTOR
OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY
DEPARTMENT OF ENERGY

BEFORE THE
HOUSE SCIENCE COMMITTEE
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

MAY 1, 1996

STATEMENT OF
DR. TERRY R. LASH, DIRECTOR
OFFICE OF NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY
DEPARTMENT OF ENERGY

BEFORE THE
HOUSE SCIENCE COMMITTEE
SUBCOMMITTEE ON ENERGY AND ENVIRONMENT

INTRODUCTION

Mr. Chairman, I am pleased to have this opportunity to present the fiscal year 1997 budget request for the Department of Energy's Office of Nuclear Energy, Science and Technology. The Office of Nuclear Energy, Science and Technology is the home for the United States government's core expertise in nuclear engineering and technology. Our activities cover a wide range of programs from working to enhance domestic and international nuclear safety and providing critical isotopes to health care providers and industry, to building the nuclear systems needed to explore outer space and support the nation's defense. My discussion today will not include the budget request for our International Nuclear Safety and Nuclear Security/Russian Plutonium Reactor Shutdown Initiatives or the Naval Reactors program, which are all under the jurisdiction of the National Security Committee.

Our office supports critical strategic, technical, and nuclear safety missions of the United States government. For example, the Office of Nuclear Energy, Science and Technology is leading U.S. technical efforts to ensure that Russian weapons-grade uranium is blended down so that it will never again be used to make nuclear weapons. Nuclear technology developed by this office is being used to provide long-term, durable power sources for national security missions. We support important U.S. foreign policy goals by implementing an agreement to cease production of plutonium in Russia as well as providing technical support to cease weapons-grade plutonium production in North Korea.

One of our most important programs addresses critical technical challenges to assure that one of this nation's important nuclear energy resources--110 nuclear power plants that currently generate more than one-fifth of our electricity--can operate safely and economically for many years to come. We are also cooperating with the private sector to design next-generation nuclear power plants that can provide electricity early in the next century at a competitive cost. These new plant designs incorporate advanced, passive safety features and apply three decades of experience in operating light water reactors to develop technologies for plants that are easier and lower cost to build, simpler to operate and maintain, more reliable, and safer than current nuclear power plants. Our program will maintain the option to build and operate safe, economic nuclear power plants in the U.S. for many years to come.

We also continue our focus on applying nuclear science and technology to improve our world and expand the frontiers of knowledge. Our isotope program is a critical resource to U.S. industry and university researchers. Health care providers rely on us as a source of vital medical isotopes needed to diagnose and treat many illnesses. This Office is an active participant in U.S. and international space programs. Radioisotope thermoelectric generators built by the Office of Nuclear Energy, Science and Technology supply power to U.S. spacecraft recently sent to the outer planets, including the Galileo spacecraft that sent a probe into the atmosphere of Jupiter. From these missions, scientists and astronomers are learning more about the beginning of the universe and lessons that can be applied to problems here on Earth. In 1997, the National Aeronautic and Space Administration will launch its Cassini spacecraft to Saturn. Like previous successful missions to the outer planets, Cassini will be powered by systems built by the Office of Nuclear Energy, Science and Technology.

The Office of Nuclear Energy, Science and Technology is also responsible for the management of the Advanced Test Reactor in Idaho in support of the Naval Reactors Propulsion Program; oversight of facilities leased to the United States Enrichment Corporation; management of approximately 47,000 cylinders of depleted uranium hexafluoride in storage at Oak Ridge, Paducah and Portsmouth Gaseous Diffusion Plants; and the deactivation of liquid metal reactors, including the Fast Flux Test Facility in Hanford, Washington, and the Experimental Breeder Reactor-II in Idaho. Nuclear Energy also manages the research reactors funded by the Office of Energy Research including the High Flux Isotope Reactor at the Oak Ridge National Laboratory, and the High Flux Beam Reactor, and Brookhaven Medical Research Reactor at the Brookhaven National Laboratory.

Since August 1993, Nuclear Energy has worked to significantly realign its administrative, scientific, and engineering resources while making the office more efficient in meeting the needs of its customers. Our organizational restructuring effort meets, and in many cases surpasses, National Performance Review goals and improves the efficiency and effectiveness of Headquarters operations. Over the past two and one-half years, Nuclear Energy has reduced Headquarters staff by 44 percent. Over the same period, Nuclear Energy has reduced support service contracting by 64 percent.

We have also focused our activities to work only on high-priority programs for which the federal government's participation is required. To date, Nuclear Energy has eliminated research and development of liquid metal reactors, advanced high temperature gas reactors, and SP-100 and thermionics space reactor power systems, while shutting down unneeded and costly facilities. With the formation of the United States Enrichment Corporation, our Office of Uranium Programs has been eliminated and its remaining duties subsumed in other Nuclear Energy, Science and Technology program.

The Office of Nuclear Energy, Science and Technology's primary priority is to apply nuclear expertise to enhance the economic and national security interests of the United States and to increase the safety of nuclear reactors at home and abroad. These changing priorities require new ways of doing business. Using a matrix management system, we have been able to streamline our operations and continue to provide critical services using a relatively small staff of technical experts to perform the diverse range of activities.

The office continues to downsize and eliminate low-priority activities. In fiscal year 1997, we are requesting $348.1 million for the programs of the Office of Nuclear Energy, Science and Technology, which is $33.2 million less than appropriated in fiscal year 1996. This level of funding, however, does not include the resources needed for activities funded by the National Security Committee.

The Office of Nuclear Energy, Science and Technology fiscal year 1997 funding request is outlined in the following table:

Budget Authority
($ in Millions)

Program Element Request		FY 1997
Nuclear Energy Research and Development		$156.3
Light Water Reactors	40.0	
Advanced Radioisotope Power Systems	40.0	
Nuclear Technology Research and Development	30.0	
Program Direction	18.5	
Oak Ridge Landlord	16.0	
Test Reactor Area Landlord	4.0	
Advanced Test Reactor Fusion Irradiations	0.8	
University Nuclear Science and Reactor Support	7.0	
Termination Costs		79.1
International Nuclear Safety and Chornobyl Initiative		66.2 *(a)*
Nuclear Security/Russian Plutonium Reactor Shutdown		6.0 *(b)*
Isotope Support		12.7
SUBTOTAL, Nuclear Energy		320.3
Uranium Programs		27.8
TOTAL NUCLEAR ENERGY, SCIENCE AND TECHNOLOGY REQUEST		$348.1

(a) $66.2 million requested in Other Defense Activities appropriation
(b) $6.0 million requested in Other Defense Activities appropriation

I will now provide the Committee with greater detail concerning the importance of our programs and the benefits they provide to the American people.

NUCLEAR ENERGY R&D

The Office of Nuclear Energy, Science and Technology proposed Nuclear Energy R&D funding for fiscal year 1997 will maintain the federal government's core expertise in nuclear energy and perform critical missions that no other organization in the government is qualified to address. In particular, these funds will allow the Department to meet its commitments to complete the design certification of advanced light water reactors and provide power sources for the National Aeronautic and Space Administration's Cassini mission to Saturn and for vital national security missions. We are also proposing to continue research and development of electrometallurgical technology to treat EBR-II spent nuclear fuel. The environmental analysis for a demonstration of this technology on a limited amount of EBR-II spent fuel is underway. Depending on the results of the proposed demonstration, DOE may propose a broader application of this technology

Light Water Reactors

The United States operates more light water reactors than any other nation. One hundred and ten nuclear power plants provide more than 20 percent of the electricity generated in this country. Light water reactors are, and for decades to come will continue to be, an important element of electricity supply in the United States, in other industrialized countries, and in emerging economies. One of the key goals of the Office of Nuclear Energy, Science and Technology is to assure that currently operating plants can operate safely and efficiently for many years to come and that the light water technology remains an option for new nuclear plants that may be built early in the next century.

The Department believes that its light water reactor R&D activity transcends its importance as a domestic energy security issue. The federal government has a key role in assuring that U.S. industry is free to compete for the design and construction of nuclear plants overseas. The export of U.S. technology, with our high standards of safety, would enhance the safety of nuclear power in other countries and provide financial benefit to United States firms and our overall economy. Alternatively, if the United States is not participating in advancing the state of the art, we will have vastly reduced influence in shaping the approach the international community takes in implementing new plants. Many of the Federal Government's nonproliferation, foreign trade, nuclear safety, and other priority interests benefit both directly and indirectly from our light water reactor program.

If the United States government is to provide this international leadership, it must have an activ program involving light water reactors. Although primary responsibility for maintaining the Unite State's capability to build new nuclear plants remains with industry, our light water reactor effort focus on technical issues that affect broad sections of the industry, and rely on the special expertis located within the Department of Energy and at its multi-program laboratories.

The proposed light water reactor program for fiscal year 1997 is focused on two areas of work. Firs the Department will continue its role in achieving Nuclear Regulatory Commission design certificatio of advanced light water reactors. The Department has made significant progress in this area ar expects to complete two designs before the end of CY 1996. As our work on next-generation plan moves toward completion, we propose to focus greater attention on some of the generic issues th could affect the safe operation of existing plants or could cause their premature shutdown if they a not resolved.

These programs are conducted in cooperation with industry and many overseas entities. Forei participants, for example, are very active in the program's design, development and testing activities and their involvement is essential to the success of the program. Similarly, collaborative R&D activities with U.S. industry, including the Electric Power Research Institute are central to resolution of both advanced and current commercial light water reactor issues.

While the level of funding we have requested is very modest and actually significantly less than many in industry believe is appropriate, it enables the United States government to ensure that our private sector maintains the capability to build and service nuclear power plants. Without government leadership, it is likely that the erosion of our domestic infrastructure will accelerate and the safety and viability of 22 percent of the United States electricity generating capacity will be threatened. We will then become dependent on industry from France, Japan and other countries should a future market appear in the United States for new plants.

Advanced Light Water Reactors

The end goal of our advanced light water reactor research and development program is to provide Nuclear Regulatory Commission certified, standardized designs as an option for electricity generation. These advanced designs can provide enhanced safety and reliability over existing plants and meet the needs of electric utilities as reflected in the industry's Utilities Requirements Document. With plant modularization and prefabrication techniques, certified, commercially standardized advanced light water reactor designs will offer the prospect of significantly improved competitiveness through reductions in life-cycle costs and construction times.

Certification activities focus on two areas: first, design development, testing, and analyses needed to complete the Nuclear Regulatory Commission safety review process; and, second, resolution of technical and regulatory issues required for Nuclear Regulatory Commission acceptance of new, innovative safety features. The new designs will apply, for the first time, the new Nuclear Regulatory Commission design certification process under Title 10 of the Code of Federal Regulations Part 52.

Three advanced light water reactor plant designs are being reviewed for certification by the Nuclear Regulatory Commission: the Advanced Boiling Water Reactor, the System 80+, and the AP-600. Program activities related to a fourth plant, the Simplified Boiling Water Reactor, are currently under review and may not continue in FY 1997.

The Advanced Boiling Water Reactor and System 80+ are large plant designs, each with a capacity of about 1350 megawatts-electric, which are considered "evolutionary" because they incorporate advanced systems that build on technology already in use. These designs were the first advanced light water reactors to be submitted to the Nuclear Regulatory Commission, which issued Final Design Approvals for these designs in the summer of 1994. We expect the final rule for design certification of both later this year, following resolution of comments received during the public review of draft certification rules. Once these certifications are issued, that part of our program will have been brought to a successful conclusion.

The AP-600 is a smaller plant of about 600 megawatts-electric which is considered "passively-safe" because it employs the physical laws of nature (e.g., convection, evaporation, gravity, etc.) to maintain safe temperatures in the reactor core. In addition to new passive safety systems this plant design employs substantial system simplifications that will facilitate ease of construction, operation, and maintenance. We expect Nuclear Regulatory Commission Final Design Approval of the Westinghouse AP-600 by the spring of 1997, with certification following about one year later.

Two of these advanced light water reactor plant designs, the Advanced Boiling Water Reactor and the AP-600, are also in the First-of-a-Kind Engineering program. In this activity, designs for these advanced light water reactor plants are being developed to a level of detail beyond that required for Nuclear Regulatory Commission certification. The greater level of detail will encourage a high degree of standardization among plants of the same type. This greater level of detail will also allow the Department to make reliable estimates of the cost and time required for plant construction.

The Advanced Boiling Water Reactor First-of-a-Kind Engineering program will be completed in 1996. The AP-600 First-of-a-Kind Engineering activity will be about 90 percent complete by the end of fiscal year 1997, and will be completed after the Nuclear Regulatory Commission has certified the design in FY 1998. This approach is needed to assure that the detailed design is fully consistent with the certified design.

The Department's cooperative agreement with the Advanced Reactor Corporation to conduct the First-of-a-Kind Engineering program provides for the federal government to recoup its costs on the program based on future sales of nuclear power plants or licensing of advanced light water reactor technology. The agreement specifies that the Department will receive a pro-rata share of any royalties received by the Corporation based on the proportion of the Department's contribution to the program. (ARC royalties are $75,000 for each $1 million provided to a vendor in the program for sales within 20 years of the contract date.) In addition, any funds that the Department provides to vendors beyond $50 million for design certification activities are reimbursed through initial plant sales. Using these mechanisms, the Department assures that taxpayers benefit directly from any sales of advanced nuclear power plants in this program to overseas markets. These markets, which include Japan, China, and other nations interested in U.S. technology, have significant near-term potential and could represent billions of dollars in exports to U.S. industry.

In support of advanced light water reactor certifications, the Department's national laboratories are evaluating severe accident scenarios and potential consequences in our Advanced Reactor Severe Accident Program. The program applies methods and technologies developed in the Department of Energy, Nuclear Regulatory Commission, and international severe accident research programs to ensure access to the most up-to-date safety technology available anywhere. In fiscal year 1997, we will include international participation in the severe accident assessment of in-vessel retention of molten-core materials and investigations of coolability of ex-vessel core melt materials.

In summary, the Department is bringing its current advanced light water reactor program to a successful conclusion. With two plants expected to receive design certifications in 1996 and the third following in 1998, we expect that the federal government's research and development program on new reactor designs will be complete, thus allowing us to redirect our nuclear expertise to other challenges.-

Commercial Light Water Reactors

The currently operating 110 U.S. nuclear power plants represent an investment of hundreds of billions of dollars; this investment has yielded approximately 100 gigawatts of electric capacity. These plants currently generate 22 percent of our Nation's electricity. The Department believes that it can address a limited number of critical technical issues and allow this critical contribution to be maintained longer, more efficiently and with enhanced safety. If no action is taken, this source of electricity will decline early in the next century when the existing licenses of a large number of plants begin to expire. The Energy Information Administration, for example, predicts that about half of all U.S. nuclear plants could be shut down by 2015. Most of this capacity would have to be replaced by electric capacity dependent upon fossil fuels.

To facilitate the continued safe and reliable operation of many of these plants, we are cooperating with industry and the Nuclear Regulatory Commission to develop technologies to manage the effects of component degradation from long-term plant operation. Material degradation evaluations in fiscal year 1997 will focus on a variety of technical issues, including: a second demonstration of reactor pressure vessel annealing technology to reverse degradation of vessel material, cable aging, reactor vessel internals stress corrosion cracking, instrument and control upgrades, nondestructive examination techniques, adequacy of fatigue margins, and steam generator tube integrity inspection. In fiscal year 1997, Nuclear Energy will conduct technical activities focused on enhancing the safety and efficiency of U.S. nuclear plants. We proposed to investigate ways of applying technologies developed for naval and research reactors to further optimize the once-through fuel cycle. A successful technology program in this area would not only reduce generation of spent fuel and increase efficiency of nuclear power plant operations, but would encourage other countries using nuclear power to rely on a highly efficient once-through fuel cycle rather than on reprocessing. We will also develop improved information management systems and enhanced man-machine interfaces to facilitate further gains in safety and efficiency.

Our light water reactor program is highly focused and designed to provide near-term benefits. We believe this program represents an appropriate government role in research and development and represents wise and limited use of taxpayer resources. This program also enables the Department to maintain its core competence in nuclear technology and this expertise is needed to serve many critical nonproliferation and nuclear safety missions.

Advanced Radioisotope Power Systems

A cornerstone of the nation's deep space exploration program, radioisotope power systems have been in use for more than three decades. They are proven, reliable, and maintenance-free power supplies capable of producing either heat or electricity for decades under the conditions required for deep space and unattended terrestrial missions. The methods of power generation employed in these systems are based on the radioactive decay of plutonium-238. (Plutonium-238 cannot be used to make nuclear explosives.) These heat-generating systems are particularly suited for applications where large arrays of solar cells are not practical, as on the far side of the Moon, or for deep-space probes beyond the inner planets. Such applications require power sources for the life of the mission and plutonium-238 is the only radioisotope that meets the National Aeronautics and Space Administration's high-specific power, long-life, and low short-range radiation requirements.

The electric generating power systems we currently produce, called radioisotope thermoelectric generators, have enabled the Galileo spacecraft, currently in orbit around Jupiter, to transmit the first ever, close-up pictures of an asteroid (Gaspra), and to take pictures of the Levy-Shoemaker comet as it impacted Jupiter. Radioisotope thermoelectric generators are also successfully powering the Ulysses spacecraft in its journey to the Sun (solar panels are too fragile to be used for missions close to the Sun) and will be used to power the Cassini mission to Saturn. Additionally, our heating power systems, called radioisotope heater units, provide heat to keep spacecraft instruments warm in many of these deep-space missions.

Currently, the program is focused on providing three radioisotope heater units for the National Aeronautics and Space Administration's Mars Pathfinder mission planned for launch in December 1996, and three radioisotope thermoelectric generators and 157 radioisotope heater units to support the Cassini mission, planned for launch in October 1997. The first of the three radioisotope thermoelectric generators for the Cassini mission has been fully assembled and is being tested and certified. Efforts in fiscal year 1997 will focus on completing the fabrication and testing of the remaining radioisotope thermoelectric generators for the Cassini mission. Los Alamos National Laboratory is fabricating the plutonium-238 fuel pellets and encapsulating them within iridium clad vent sets. The Mound Facility is in the process of assembling the General Purpose Heat Source modules which encase the clad plutonium-238 fuel pellets to form the heat source for the generators. Lockheed Martin Astro Space is fabricating the thermoelectric converters that will house the heat sources.

By late fiscal year 1997, all three radioisotope thermoelectric generators plus one spare will be delivered to the Kennedy Space Center and installed on the Cassini spacecraft for an October 1997 launch. The shipment of radioisotope thermoelectric generators will be achieved using a new shipping container currently undergoing certification review. The Department will support test activities at the Kennedy Space Center to verify operation of radioisotope thermoelectric generators and prepare them for installation on the Cassini spacecraft just prior to launch. The Cassini safety program will be completed in fiscal year 1997 with the issuance of the Final Safety Analysis Report.

In fiscal year 1997, we will continue to participate in the safety reviews and analyses leading to approval for a December 1996 launch of the Mars Pathfinder. We will also support ground operations and emergency preparedness planning for both the Cassini and Pathfinder launches and work with the National Aeronautics and Space Administration on technology and radioisotopic power supplies which may be needed by National Aeronautics and Space Administration for future deep space missions such as Mars Lander and Pluto Express.

Nuclear Energy is leading an evaluation, in concert with the user agencies, to determine the best way to maintain the basic fabrication capabilities at the Oak Ridge, Los Alamos and Mound facilities, at lowest possible cost while preserving the required expertise. The intent is to ensure that the facility infrastructure is in place to allow radioisotope thermoelectric generators to be fabricated for future missions.

Our Special Application program will continue to develop technologies, and to provide new and refurbished power supplies for terrestrial national security missions. For example, efforts will continue on improving energy conversion efficiency by investigating cascading PbTe/BiTe thermoelectrics. We will conduct specialized nuclear safety tests and analyses to support development of a new 50 watt-electric power source. Plans made by our national security customers indicate that these power sources will be vital to United States security interests for many years to come.

Nuclear Technology Research and Development

The Nuclear Technology Research and Development program funds the research and development of technologies for high-priority Department of Energy missions. In fiscal year 1997, responding to the guidance provided by Congress in the previous fiscal year and subject to completion of an environmental review of the project, these funds would be devoted to a demonstration of electrometallurgical technology for the treatment of Department of Energy EBR-II spent fuel. This technology has the potential to prepare a wide array of Department of Energy spent fuels for safe storage and eventual geologic disposal.

The Department of Energy is responsible for the safe storage of approximately 2,700 metric tons of spent nuclear fuel discharged from Department of Energy reactors. A standard, cost-effective means for treating this spent fuel for ultimate disposal is needed. The electrometallurgical treatment process being developed at Argonne National Laboratory has the potential to treat up to 90 percent of the Department of Energy's spent nuclear fuel inventory. In concept, it would allow for the treatment of various fuel types by a single method. This process produces two common high-level waste forms and could offer significant savings in commonality of process equipment and waste forms.

Significant progress is expected in fiscal year 1996 in several key technical areas. We propose to complete small-scale experiments as part of continued electrometallurgical technology research and development for treatment of Experimental Breeder Reactor-II spent fuel. We are also proposing waste treatment research and development and waste form qualification to support waste form testing waste treatment research and development and waste form qualification to support waste form testing and identification of the preferred waste forms for treated Department of Energy spent fuels.

Nuclear Energy is preparing an environmental assessment on our proposed demonstration of electrometallurgical treatment technology on a small portion of the sodium-bonded spent fuel from the Experimental Breeder Reactor II at the Argonne National Laboratory-West site. We are now completing work on that assessment and we expect that a determination on whether a Finding of No Significant Impact can be issued as a result of this analysis will be made very soon and we will keep you apprised of the status of this activity. This project is discussed in detail under "Termination Costs."

Finally, to promote global cooperation on nuclear safety and the open exchange of nuclear safety information, the Department of Energy has established an International Nuclear Safety Center at the Argonne National Laboratory. $5 million is requested to support this activity in FY 1997. Through the Center, we are able to support collaborative research and development with nuclear safety research institutions worldwide. In fiscal year 1996, the center is initiating cooperation with a similar center in Russia. Plans for fiscal year 1997 include initiating cooperative projects with the Ukrainian research center and with organizations in Germany, Japan, France, and Sweden. The U.S. center maintains the information and technical expertise necessary to advise the United States government and international bodies on urgent safety and nonproliferation matters, such as the safety prospects for the partially-completed Juragua reactor in Cuba and Russian nuclear exports to Iran.

Program Direction

This account supports Headquarters and Operations Office personnel who provide technical direction not only to Nuclear Energy Research and Development activities, but also to efforts funded by other Department accounts (*e.g.*, nuclear safety activities conducted in Russia, Ukraine, and Central and Eastern European countries funded under Other Defense Activities; technical direction for the operation of Energy Research Reactors funded by the Office of Energy Research; and activities at the Fast Flux Test Facility as funded in the Environmental Management account); other Federal agencies; the nuclear industry; and foreign governments. In fiscal year 1997, this account will also provide funding for the Working Capital fund.

In fiscal year 1997, our staffing is expected to drop to 123. We have been reducing headquarters staffing since August of 1993, when we had 258 personnel on board. By the end of fiscal year 1997, we will have surpassed the Administration's National Performance Review Goal of a 50 percent reduction in Headquarters staffing. The fiscal year 1997 budget includes funding for buy-outs and lump sum leave payments necessary to achieve these reductions. Continued reductions in staffing in accordance with the Strategic Alignment Initiative are planned in future years. It should be noted that this item no longer includes support for Historically Black Colleges and Universities and the Nuclear Energy and Health Physics Fellowships Program–these items have now been placed in the University Programs account.

Oak Ridge Landlord

As the headquarters office responsible for Oak Ridge, the Office of Nuclear Energy, Science and Technology budgets for centralized Oak Ridge Operations Office infrastructure requirements and general operating costs for those activities outside plant fences of the Oak Ridge National Laboratory, the Y-12 Plant, and the K-25 Plant. These activities include environmental, safety and health efforts and quality assurance facility compliance activities; environmental, safety and health upgrade of Department of Energy-owned facilities including the Water Plant, which provides potable water for the Y-12 and Oak Ridge National Laboratory plants, and the City of Oak Ridge; training and development activities; support to the Directives Management Group; technology development support to small and small disadvantaged businesses; maintenance of the Oak Ridge Reservation's roads and grounds (22 miles of paved roads and associated rights-of-way, 32 cemeteries, and four bridges); operation of the Emergency Operations Center; payments-in-lieu-of-taxes to the local community; and physical security.

Test Reactor Area Landlord

The Idaho Test Reactor Area facilities are used to support program work for Naval Reactors, the Isotope Production and Distribution Program, and various other Department programs. Test reactor area landlord activities in fiscal year 1997 include general facility and utility maintenance and repair, construction project operating support, General Plant Projects, and a major line item construction project. Under General Plant Projects, plans include addition of a truck enclosure for the test reactor area hot cells for weather protection of workers and radioactive shipments, and an upgrade to the aging test reactor area site demineralized water plant.

The major line item construction project is to upgrade facilities at the Test Reactor Area to bring these older buildings into compliance with new Departmental fire and life safety regulations and national codes and standards. The actual construction is to begin in fiscal year 1997. The Fire and Life Safety Project has a total estimated cost of $15.5 million and will be completed in FY 1999.

University Nuclear Science and Reactor Support

The Department's University Nuclear Science and Reactor Support Program carries out the important task of supporting nuclear science education and research in the United States. Applying modest funds, this program works with universities and colleges across the Nation to maintain nuclear education programs, support outstanding students, and continue the operation of research reactors. Most of the funds in our request will be used to provide fresh fuel to these reactors, to remove spent fuel, and to upgrade the safety and maintenance capabilities at the 34 university research reactors. These reactors are used for educational purposes, to conduct important materials research, and to make vital isotopes.

This program replaces the Department's University Reactor Assistance programs that were transferred from the Office of Science Education and Technical Information in fiscal year 1995. A new Decision Unit was created to address this work, and the more representative program title, "University Nuclear Science and Reactor Support," was assigned.

In fiscal year 1997, we will continue to supply fresh fuel to and transport spent fuel from universities requiring such assistance. In addition, we will continue converting university reactors that currently use highly enriched uranium fuel to use low enriched uranium fuel, advancing the Administration nonproliferation goals.

We also plan to support U.S. universities and colleges to modernize reactor safety systems and improve their operational capabilities. Additionally, we provide support for the reactor sharing program, which allows students and faculty at educational institutions which do not own reactors the opportunity to use the reactors for research. Our planned activities, while less than what universities tell us is required, are designed to make the most of the funding available for this program.

We also plan to continue to partner with the electric utility industry in funding university nuclear engineering programs by providing research grants to universities that receive similar commitments from the utilities. We intend to provide, as in the past, funding equal to the amount contributed by private organizations, but not to exceed $50,000 per university per Department grant. In fiscal year 1997, we expect to fund $800,000 in grants which will be matched by participating utilities for a total program of $1.6 million.

A significant change from the previous fiscal year is that Nuclear Energy support to Historically Black Colleges and Universities and the Nuclear Energy and Health Physics Fellowships programs will be funded from this account. Previously, these programs were funded through the Program Direction account, which has been correspondingly decreased.

It is very important that Congress recognize that this new responsibility, which provides approximately $1.5 million to 40 outstanding graduate engineering students across the country, accounts for nearly half the requested increase in funding for FY 1997.

Advanced Test Reactor Fusion Irradiations

Our budget includes funding to resume design and initiate fabrication of a test vehicle for the Fusion Materials Irradiation Experiments Program. With the shutdown of the Fast Flux Test Facility and Experimental Breeder Reactor-II, the Advanced Test Reactor was selected to conduct the irradiation program. In accordance with an agreement with the Office of Energy Research, we are building the test vehicle for the Advanced Test Reactor. This program was rescheduled in fiscal year 1996 consistent with the schedule requirements of the Department of Energy/Monbusho program. The primary focus of the initial irradiation program will be to test advanced materials to be used as components in the fusion systems first wall. Fabrication, installation and testing will be completed by the end of fiscal year 1998 when fusion materials irradiations are scheduled to begin. Funding for the actual experiment irradiations and servicing in the test reactor area hot cells will be provided by the Office of Energy Research. The first series of irradiation tests is a collaborative effort with Monbusho of Japan. Further fusion program testing in the Advanced Test Reactor under sponsorship of the Office of Energy Research is also envisioned.

TERMINATION COSTS

The Termination Costs program provides for the shutdown of unneeded nuclear facilities at Argonne National Laboratory-West and termination of the Modular High Temperature Gas Reactor program. In addition, the Office of Nuclear Energy, Science and Technology manages activities at the Fast Flux Test Facility. This effort has remained on or ahead of schedule through the past year. Defueling of the reactor core was completed in May 1995, four months ahead of schedule. Fast Flux Test Facility activities are funded with Environmental Management appropriations.

Argonne National Laboratory-West

In October 1994, the Department initiated deactivation of the Experimental Breeder Reactor-II and other unneeded facilities at Argonne National Laboratory-West. Funds are needed to place the facilities in an industrially and radiologically safe shutdown condition for transfer to the Office of Environmental Management. The major facilities to be shut down at Argonne National Laboratory-West include the Experimental Breeder Reactor-II, the Fuel Manufacturing Facility, and the Transient Reactor Test Facility. Planned Experimental Breeder Reactor-II shutdown activities include removal of the fuel and blanket assemblies; treatment of the fuel and blanket assemblies in the Fuel Conditioning Facility; and removal and processing of the sodium coolant from the reactor.

During FY 1995, the Fuel Conditioning Facility successfully completed an Operational Readiness Review in preparation to treat the Experimental Breeder Reactor-II fuel and blanket assemblies. Plans are to use this facility to place the Experimental Breeder Reactor-II driver fuel in a suitable form for long term storage.

During FY 1996, defueling of the Experimental Breeder Reactor II continues on schedule. The reactor is currently almost two-thirds defueled and is on schedule to complete defueling by the end of calendar year 1996. Modification of the Sodium Process Facility (SFS) will be completed by the end of FY 1996 to enable initiation of the treatment of Fermi reactor sodium, that has been stored on-site.

On May 3, 1996, the public comments period will close for the "Draft Environmental Assessment for Electrometallurgical Treatment Research and Demonstration Project in the Fuel Conditioning Facility (FCF) at Argonne National Laboratory-West" that was issued in January 1996. If the review process results in a Finding of No Significant Impact, the FCF will demonstrate technology for the treatment of fuel from the Experimental Breeder Reactor II beginning in FY 1996.

In FY 1997, defueling of the Experimental Breeder Reactor II will be completed. Operation of the Sodium Process Facility will be initiated, and the Fermi reactor sodium will be processed consistent with a commitment to the State of Idaho. Draining of the primary sodium from the Experimental Breeder Reactor II is planned to start in the fourth quarter. The electometallurgical fuel treatment technology demonstration is planned to continue in the FCF.

Gas Turbine-Modular Helium Reactor

The Gas Turbine-Modular Helium Reactor program was terminated by Congress in FY 1996. A closeout plan has been developed and is being implemented. Program expenditures for FY 1996 and 1997 support activities required to terminate the program, including the collection, packaging, shipment and disposition of DOE supplies, equipment and materials. All funding provided to program contractors is being used to terminate the program and place all facilities in an industrially and radiologically safe condition.

ISOTOPE SUPPORT

Through the Isotope Production and Distribution Program, we provide radioactive and enriched stable isotope products and associated services to a widely varied domestic and international market. These products and services are used in medical research and treatment, and national defense and industrial applications. Isotopes produced in the Department's facilities are used most notably for treating cancer and such life threatening diseases as non-Hodgkin's lymphoma. In fiscal year 1997, it is expected that revenue from the sale of these isotopes will increase by 10 percent to $11 million.

The Department engages in isotope production activities when no domestic, private sector capability exists; where unique Government production facilities are needed such as nuclear reactors and associated hot cells, particle accelerators, and isotope enrichment facilities; or other productive capacity is insufficient to meet U.S. needs. The Department encourages private sector investment in new isotope production ventures and will sell or lease its existing facilities and inventories for commercial purposes.

The Isotope Program operates with a revolving fund and maintains financial viability through its revenues from the sale of isotopes and services, and through annual appropriations. Moreover, the Isotope Program functions as a business and, therefore, focuses attention on the quality of products and services, customer satisfaction, cost control, marketing, pricing stability, and revenue and cash collections.

The National Isotope Strategy describes two primary missions: The first is to produce and distribute certain isotopes for research and development, medical diagnostics and therapy, and other applications that are needed to meet the national interest or support our health care system. Charges for these isotopes are intended to provide reasonable compensation to the Department while encouraging the beneficial use of such isotopes. The second mission is to continue to produce and distribute, on a businesslike basis, other isotope products and services that are in commercial demand.

One of our major proposals is to establish a U.S. production capability for molybdenum-99 and related isotopes. Molybdenum-99, a precursor of technetium-99m, is critical to the Nation's health care system. Technetium-99m is used in more than 36,000 medical procedures daily in the United States alone. At present there is no U.S. source for molybdenum-99. U.S. requirements are supplied by a single aging reactor in Canada.

In order to ensure a reliable supply of this vital isotope, the Department has proposed a medical isotope production project to establish a U.S. source of molybdenum-99. Last year, the Department began preparation of an environmental impact statement pursuant to the National Environmental Policy Act to assess the environmental impacts of establishing a domestic production capability for this isotope. The environmental impact statement was completed this April. The Department plans to issue a record of decision on the proposed action in June of this year. If the final decision is made to implement the production proposal, the Department could begin establishing production capabilities and produce sample quantities of molybdenum-99 by the fall of 1996. Subsequent U.S. Food and Drug Administration approval of the molybdenum-99 could be granted in early 1997.

It is important to note that our FY 1997 request does not include funds for the proposed molybdenum-99 initiative. We determined that before new funds are requested, it is necessary to complete the environmental impact statement and issue the record of decision. Once we have determined which option in the analysis will be pursued, funding for this project (about $12 million, depending on the option selected) will be obtained from within the Department's FY 1997 budget.

While working to improve our program and service to our customers, we are also taking steps to privatize as much of the program as possible. The Department has published a Notice of Request for Expressions of Interest in the *Federal Register* and the *Commerce Business Daily* to solicit private sector concepts for participation in the Department's isotope production and distribution activities. The primary objectives of the privatization initiative are to encourage the private sector to assume a larger role in the supply of medical and other specialty isotopes; encourage the private sector to propose business arrangements for the purchase, lease or use of DOE facilities, technologies or intellectual property rights that could be used for commercial production of isotopes; and encourage the private sector to provide production, marketing, distribution, or technical services which will lead to lower overall cost and greater program effectiveness.

The Department has, as its overall goal, the reduction of costs for delivering a product to customers while increasing efficiency and reliability. Our approach is to encourage the private sector to propose methods of privatization. The Department received 30 concepts for privatization from the private sector. We expect to initiate an expedited proposal process for the most promising concepts in May 1996.

In fiscal year 1996, Congress transferred funding responsibility for the test reactor area hot cells to the Isotope Production and Distribution Program without transferring any funds. Our FY 1997 request also provides for funding of the hot cells under the Isotope Program. The program will continue to operate and maintain the test reactor area hot cells at the Idaho National Engineering Laboratory. Their specific functions include: processing and shipping isotopes produced in the advanced test reactor to medical and industrial users; disassembly, processing and shipping of experiments irradiated in the advanced test reactor, if analysis is to be done elsewhere; and conducting the photographic, metallographic and scanning electron microscope examinations of irradiated material from the advanced test reactor or elsewhere as required by various program sponsors.

URANIUM PROGRAMS

Uranium Programs activities are focused on providing support for domestic and international uranium and nuclear technology issues. For example, the Office of Nuclear Energy, Science and Technology is leading the Department's implementation efforts to assure that Russian low enriched uranium being purchased by United States Enrichment Corporation is actually derived from highly enriched uranium removed from Russian weapons. In addition, the Department retains certain responsibilities for the gaseous diffusion plant facilities it leased to the United States Enrichment Corporation, as required by the Energy Policy Act of 1992. Finally, we are forming partnerships with U.S. industry to capitalize on the multi-billion dollar investment made by the Department in uranium enrichment technologies that can now be used in other industrial applications.

Transparency Measures

The Office of Nuclear Energy, Science and Technology has the Department's lead in implementing the Government's international arms control and nonproliferation technical objectives allowing the United States Enrichment Corporation to purchase more than 15,000 metric tons of Russian low enriched uranium derived from 500 metric tons of highly enriched uranium. Our personnel are working closely with others in the Department and other government agencies to help build confidence that the low enriched uranium delivered to the United States Enrichment Corporation has been derived from Russian highly enriched uranium removed from nuclear weapons. While the bilateral Protocol on Further Arrangements cleared the way for deliveries of Russian enriched uranium to the United States Enrichment Corporation, we are continuing to work with Russia to establish the detailed monitoring procedures. During the first week of April 1996, 12 annexes to the bilateral Protocol on Further Arrangements were signed including annexes establishing detailed monitoring procedures to be used at two facilities in Russia and at enrichment and fuel fabrication facilities in the United States. We are continuing to work with Russia to establish plant specific monitoring procedures for the Krasnoyarsk facility.

The Protocol on Further Arrangements calls for both special monitoring visits to facilities where material will be processed, as well as the establishment of permanent monitoring offices at certain facilities in each country. By 1997, we expect to have established a permanent U.S. monitoring office at the Ural Electrochemical Integrated Enterprise plant located at Novouralsk. The Ural Electrochemical Integrated Enterprise plant is one of two sites where highly enriched uranium oxide will be converted into low enriched uranium for delivery to the United States. The Russians have indicated that blending will also occur during 1996 at Krasnoyarsk. During 1997 a permanent U.S. monitoring office also is planned for Krasnoyarsk. Additional Russian blending sites may be added as the quantity of highly enriched uranium to be converted increases. Special monitoring visits will also be conducted at the Siberian Chemical Enterprise near Tomsk, Russia, where highly enriched uranium metal is converted to oxide. The combination of a continuous presence and periodic inspections is expected to provide a sufficient degree of confidence that the low enriched uranium being delivered to the United States is derived from highly enriched uranium. Fiscal year 1997 is expected to be the first year monitoring activities are fully implemented.

Activities Related to the United States Enrichment Corporation and Enrichment Plant Sites

As a result of the Energy Policy Act of 1992, the Department and the United States Enrichment Corporation are bound together by a series of agreements that require interdependent activities in many areas. These include regulatory compliance, lease management, site operations, pre-existing liabilities at the Department's gaseous diffusion plants now leased by the Corporation, and uranium sales.

The Office of Nuclear Energy, Science and Technology also has the responsibility for nuclear safety regulatory oversight of the gaseous diffusion plants until the Nuclear Regulatory Commission assumes this responsibility as required by the Energy Policy Act of 1992. The Department of Energy and the United States Enrichment Corporation are working together to ensure the continued safe, efficient operation of these plants. The Energy Policy Act designated Nuclear Regulatory Commission as the regulator of the plants. However, Nuclear Regulatory Commission oversight will not start until the Nuclear Regulatory Commission certifies the United States Enrichment Corporation operation of the plants based on compliance plans prepared by our office and certification applications prepared by the United States Enrichment Corporation. The United States Enrichment Corporation submitted its certification applications in mid-September 1995 and our compliance plans were submitted in early November 1995. The Nuclear Regulatory Commission is expected to certify the United States Enrichment Corporation for operation of the plants in the fall of 1996. Following a 120-day transition period after the date of certification, Nuclear Regulatory Commission will assume responsibility for the day-to-day regulatory activities.

In accordance with the Energy Policy Act, the Department of Energy remains financially responsible for the nuclear safety upgrades needed at the plants to meet Nuclear Regulatory Commission standards. These upgrades are delineated in the compliance plans and are estimated to cost about $130 million and take between three and five years to complete. Cost of the upgrades will be paid through the transfer or sale of excess Departmental inventories of natural uranium and low-enriched uranium derived from highly enriched uranium, as stipulated in an earlier agreement with the United States Enrichment Corporation.

The Department and the United States Enrichment Corporation entered into a six-year lease in July 1993 that sets forth the conditions under which the United States Enrichment Corporation operates the enrichment plants. As provided in the lease, the United States Enrichment Corporation, with two-years notice, can terminate the lease for one or both of the enrichment plants. The Department is beginning to plan for the safe and orderly return of the enrichment plants for eventual decontamination and decommissioning. As part of the lease, the Department is also responsible for collection, containment, and cleanup of polychlorinated biphenyl waste through a troughing system in seven process buildings leased to the United States Enrichment Corporation.

After the transfer of the natural uranium and low enriched uranium inventories required by the United States Enrichment Corporation to satisfy its contracts, the Department has retained an inventory of natural uranium, which is surplus to national security needs. In fiscal year 1997, the Department expects $42.2 million in uranium revenues from the sale of an initial portion of this material. Consistent with its responsibilities under the Energy Policy Act of 1992, the Department is working to prudently sell its excess natural and low-enriched uranium inventories while taking into consideration the effect of these sales on the domestic uranium industry.

More than 70 facilities at the plant sites were not leased by the United States Enrichment Corporation and remain the responsibility of the Department. As landlord for the sites, we maintain these facilities and their associated permits, manage depleted uranium inventories, shut down highly enriched uranium production facilities, and work to complete environmental corrective actions necessitated by operations prior to the United States Enrichment Corporation transition date.

Responsibility for managing the Department's depleted uranium hexafluoride inventories at the enrichment plant sites lies with our office. More than 560,000 metric tons of this material are safely stored at the sites, awaiting final disposition. We have undertaken, and are well along in conducting a program to evaluate alternative long-term disposition strategies. We completed the initial phase of the program, the Technology Assessment Project (a report was published in June 1995; the engineering analysis and the report documenting the results are nearing completion). The results will be used in the preparation of the Environmental Impact Statement and associated cost analysis. The Notice of Intent to prepare the Environmental Impact Statement was published in the *Federal Register* in late January. This initiated the Environmental Impact Statement preparation process. The draft Environmental Impact Statement is scheduled to be published in 1997. The cost analysis will also get underway this year. Based on the results of the Environmental Impact Statement, a Record of Decision selecting the preferred disposition strategy will be prepared. It is scheduled to be issued in mid-fiscal year 1998.

By fiscal year 1997, we will have completed cleaning all highly enriched uranium cells and process equipment at the shut down highly enriched uranium production facility at Portsmouth. In addition, highly enriched uranium oxides which remain stored at Portsmouth will begin to be shipped offsite in late fiscal year 1996 or early fiscal year 1997 for storage and possible blending if the material is determined to have commercial value. When all of the highly enriched uranium inventories have been removed from the site or are blended to low enriched uranium, security at the facilities will be downgraded. This will result in budget savings on the order of $16 million annually.

The Office of Nuclear Energy, Science and Technology is also responsible for satisfying financial obligations associated with enrichment operations before the transition to the United States Enrichment Corporation. Chief among these obligations are payment of post-retirement life and medical benefits to the Department's enrichment plant operating and power supply contractors. In addition, the Department of Energy is responsible for assisting in the litigation of numerous lawsuits involving claims against the Department for its operations at the enrichment plants prior to the transition date.

Technology Partnerships

The Office of Nuclear Energy, Science and Technology retains the intellectual property rights for non-uranium enrichment applications of Department of Energy-developed gaseous diffusion and gas centrifuge technologies. Patent applications have been filed for numerous enrichment technologies, reflecting the uniqueness and value of these technologies. In the past two years, more than 100 private entities have expressed interest in commercializing the Department of Energy-developed technologies for applications other than enriching uranium. Along with the Oak Ridge National Laboratory, we are engaged in efforts to work with the private sector in cost-shared cooperative technology transfer agreements for the development of future commercial uses of these technologies. These technologies offer a significant potential for new products, processes and services that will enhance U.S. industry competitiveness, lead to the creation of new jobs, and improve U.S. economy, as well as provide cleanup solutions to remove hazardous materials from government and industrial waste streams.

More than 40 commercial applications using the Department of Energy-developed inorganic membrane technology have been identified. These include chemical waste stream and gas refinery cleanup; beverage and food process purification; medical dialysis therapy and blood clarification; and hazardous particulate, liquid and gas separation and remediation. More than 25 industrial commercial applications using Department of Energy-developed centrifuge technology have been demonstrated in the laboratory, including power conditioning semiconductor devices and circuits, laser and thermal devices and detectors, axial-gap permanent magnet motors, devices for other electric drive systems, and advanced high strength composite super-alloy materials.

CONCLUSION

As the twenty-first century draws near, the Department of Energy's Office of Nuclear Energy, Science, and Technology has entered an era of new priorities. Whereas in the past, this Office had a primary mission to develop new, advanced nuclear energy technologies for long-term implementation, and now focuses its attention on applying its unique nuclear expertise to specific challenges faced by this country, both at home and abroad.

Our new priorities have required us to bring new approaches to the way we do business. We strive for ways of maximizing our limited resources by cooperating with overseas governments, private industry, and U.S. universities. We are also applying the principles of reinventing government by streamlining our organization and improving efficiency, thereby meeting our customers' needs more effectively.

We have changed with the times and now provide a broad range of critical services to meet a wide variety of National needs and priorities. We believe our FY 1997 request will enable us to carry our science and technology, national security, and facilities missions in a cost-effective and successful manner while meeting budget reduction goals.

Chairman ROHRABACHER. Mr. Schatz.

STATEMENT OF MR. THOMAS A. SCHATZ, PRESIDENT, CITIZENS AGAINST GOVERNMENT WASTE, WASHINGTON, DC

Mr. SCHATZ. Thank you, Mr. Chairman.

I have a statement for the record which I would appreciate being put in at the appropriate time.

Chairman ROHRABACHER. Certainly, without objection.

Mr. SCHATZ. I will summarize my remarks which really focus on the advanced light water reactor. I would certainly note on the basis of what Dr. Lash has stated that we appreciate the efforts being made, at least in this area of the Department, to downsize and achieve some efficiencies.

One more efficiency would be to actually end the Advanced Light Water Reactor Program which was started in fiscal year 1992 under the Energy Policy Act. It was to end or sunset in fiscal year 1996, which is this current year, providing an authorization of $250 million for first-of-a-kind engineering of new reactor design certification and licensing support activities. At this time the effort is really in the area of exporting this technology, which was clearly stated would not be permitted under the Energy Policy Act.

So we have some concern that the nuclear industry, at least domestically, has not expressed a great interest in this particular technology at this time, and when we hear about 1997 and 1998 again, based on your earlier comment about that eternal life is a government program, this may be another example where while things have been achieved, we simply continue to spend money without recognizing that we have accomplished something and move on to other areas.

I've previously testified before this Subcommittee that we are certainly not opposed to fusion research, there are a lot of ideas out there, and we know that in a smaller pie, as we have it in the Federal Government right now, we should explore every potential opportunity in the most cost effective manner.

General Electric recently dropped out of the Light Water Reactor Program. They terminated one of their programs stating that the company's internal marketing analysis showed the technology lacked commercial viability. The AP-600, which is being done by Westinghouse, is not expected to receive design certification until fiscal year 1998 or fiscal 1999. Again, the prospects for success are somewhat questionable at this time, and the withdrawal of General Electric from this program more or less acknowledges the potential for success is a little dim at this time.

One of the nuclear industry publications, Nucleonics Week, asked Westinghouse about intended markets for the AP-600, and the company apparently decided or stated that China and Indonesia were the most likely targets. China currently is prohibited from purchasing nuclear power from the United States, and it's highly unlikely that will change in the future; and Indonesia is viewed as more of a long-term prospect by industry experts. This again raises many questions about the domestic viability of the ALWR program.

Interestingly, in February when Westinghouse testified before Energy and Water Appropriations Subcommittee in the House they asked for $10 million to cover the ALWR program in fiscal 1997.

Three million was going to design and construction, and the other seven million was to pay the Nuclear Regulatory Commission to cover licensing fees which seems to be to be kind of a double hit on the taxpayers. The fees should be coming from the Company and not from the taxpayers themselves.

Last year Congressman Obey offered an amendment to strike the funding for the fifth year of the ALWR, and again was supposed to be the final year. The amendment failed, but it did receive 191 votes. There I am sure will be another effort this year to strike the funding if it moves out of the Subcommittee, and it appears that there is growing support to knock this program out of the budget.

At this time, in our view, the primary goal of DOE should be on cost recovery. Supporters will argue that ending the program will endanger prospects for cost recovery, and we are questioning whether that is in fact true.

Mr. Chairman, I'm again urging the Subcommittee to look at the options on basic research, to consider the overall budget for the Department of Energy, to take a good, hard look at the ALWR and hopefully move forward and agree that this has fulfilled its mission because there is no demonstrable domestic market at this time, and the companies themselves have not targeted the U.S. as a market. Taxpayers will not benefit from this program, and it should accept its achievements and cease to exist.

On April 10th I sent a letter to the Secretary of Energy urging her to end this program. We did not receive a response at this time. The Administration's response I imagine was to request the $40 million for the First-of-a-Kind Engineering Program indicating they still, in their view, see some mission for this ALWR project.

Mr. Chairman, that concludes my testimony, and I'll be glad to answer any questions.

Chairman ROHRABACHER. Thank you very much, Mr. Schatz.

[The prepared statement of Mr. Schatz follows:]

Testimony of
Thomas A. Schatz
President
Citizens Against Government Waste
before the
Energy and Environment Subcommittee on Science
May 1, 1996

Thank you, Mr. Chairman. It is a pleasure to testify again before the Energy and Environment Subcommittee. Seeking and following our input on matters before the subcommittee is a clear indication of your commitment to serving the best interests of the taxpayers.

First, I would like to comment on the monumental achievements of the 104th Congress. With the passage last week of the final fiscal year (FY) 1996 appropriations bill, total savings are $23 billion over FY 1995. You have successfully implemented deficit reduction without imposing an additional burden on the taxpayers, and for that you should be commended. But the work is far from over.

Although this Congress has made some headway in working toward a balanced budget, the challenge now becomes even greater. Members of Congress must continue evaluating each and every program to further eliminate unnecessary spending. One program worthy of elimination is the Department of Energy's (DOE) Advanced Light Water Reactor (ALWR).

As you know, the ALWR is funded through the Advanced Reactor Corporation for development of a new generation of nuclear reactors. The FY 1992 Energy Policy Act (EPACT), ending in FY 1996, authorized $250 million for first-of-a-kind-engineering of new reactor, design certification and licensing support activities. The guidelines that EPACT set forth clearly stated that the goal of the first-of-a-kind engineering was to develop a reactor that could be successfully certified for domestic markets by the Nuclear Regulatory Commission (NRC) by September 30, 1996. As of the end of this fiscal year, there will be two light water reactors certified by the NRC.

One concern about the ALWR program is its general direction. Participants in the program have lessened the importance of a viable domestic reactor, and instead, have targeted export markets in foreign nations. In 1995, the Nuclear Energy Institute's newsletter, Nuclear Energy Insight, reported that "all three [ALWR] designers see their most immediate opportunities for selling their designs in Pacific Rim countries." EPACT clearly prohibited funding for reactors not intended for use in domestic markets.

Nuclear power is becoming a less attractive source of power in the U. S. The industry's preferences speak for themselves. There has not been a new nuclear order placed since 1978. In a recent Washington International Energy Group survey of utility CEOs, 89 percent of those polled said their company would never consider ordering a nuclear power plant, and only eight percent predicted that nuclear power would make a resurgence.

General Electric (GE) developed the first reactor supported through the first-of-a-kind-engineering program, the Advanced Boiling Water Reactor (ABWR). A GE-designed ABWR reactor began operation in Japan this year, and GE has announced the sale of two more to Japan. Another participant in the program, Asea Brown Boveri, has offered its technology developed under the first-of-a-kind-engineering program for reactors to South Korea, and submitted the design in a bid to the Taiwan Power Company. Mr. Chairman, the sale of ALWR reactors to foreign countries clearly violates the agreement set forth in EPACT.

After the enactment of EPACT, GE and Westinghouse began development of a reactor design sparked by strong domestic interest in mid-sized reactors, roughly 600 megawatts of capacity. GE, with the Simplified Boiling Water Reactor, and Westinghouse, with the AP-600, joined the ALWR program to actively pursue a viable mid-sized reactor, believing that the reactor would enjoy success in the United States. This has not proved to be the case.

In a surprise announcement on February 28, 1996, GE terminated one of its taxpayer-subsidized R&D light water reactor programs, stating that the company's recent internal marketing analyses showed that the technology lacked "commercial viability." The AP-600 is not expected to receive design certification until FY 1998 or FY 1999, and its prospects for success remain dim. GE's withdrawal from the ALWR program acknowledges little chance for success of a 600-megawatt reactor, here or abroad.

When Nucleonics Week pressed Westinghouse about intended markets for the AP-600, Westinghouse responded that China and Indonesia were the most likely targets. The United States currently prohibits the sale or export of nuclear technology to China, and it is doubtful that will change in the future. In addition, Indonesia is viewed as more of a long-term prospect by industry experts. These factors raise serious doubts about the Westinghouse project. Taxpayers should not be expected to throw money at projects with little or no domestic commercial value.

According to EPACT, only five years were necessary to certify designs for the next generation of reactors. By the end of this fiscal year, which is the deadline for design certification, two reactors will be certified by the NRC -- meeting the goals set forth by EPACT. To allow further funding would merely sustain a program no longer needed.

Our tax dollars are also wasted in other ways in the ALWR program. While certification by the NRC is required for domestic sales of a reactor, it is not necessary for foreign sales. However, corporations seek the NRC's certification to strengthen the marketability of their reactors abroad. In other words, taxpayers are paying to ensure that corporations meet the regulatory requirements imposed, by the government. To illustrate this absurdity, Westinghouse testified before the House Energy and Water Appropriations Subcommittee on February 29, 1996 requesting $10 million to cover their ALWR program in FY 1997. Only $3 million was to go to design and construction; the other $7 million was to pay the NRC to cover licensing fees.

Last year, Rep. David Obey (D-Wis.) offered an amendment to strike the funding for the fifth year of the ALWR. Energy and Water Appropriations Chairman John Myers (R-Ind.) came to the defense of this program, highlighting the fact that it was only a five-year program, and the funding should be allowed. The amendment failed, but it did receive 191 votes. Clearly, support is growing to eliminate the ALWR.

The primary goal of DOE should be to focus on cost recovery. Although supporters will argue that ending the program will endanger any prospects for cost recovery, this is simply not true. The terms of EPACT clearly state that even if the program is terminated ahead of schedule, DOE is entitled to cost recovery.

Moreover, despite GE having one reactor operating in Japan and two more scheduled to soon begin operation, DOE has failed to recover any funds from GE. The Nuclear Energy Institute's Insight newsletter (February 1996) called the units sold to the Tokyo Electric Power Company "a clone of the GE-designed ABWR that received final design approval from the U. S. Nuclear Regulatory commission in 1994." Mr. Chairman, why hasn't DOE recovered any of the taxpayers' funds?

While the 600-megawatt reactor SBWR was deemed not commercially viable by GE, Westinghouse intends on seeing the program through to the end. Their persistence is admirable, but funding a questionable reactor does a disservice to the taxpayers. Over the years, taxpayers have provided approximately $50 million for the GE project, and cost recovery seems doubtful. Funding Westinghouse's AP-600, a similar reactor, would be throwing good money after bad.

In March, I urged this subcommittee to return to basic research in the fusion area. Today, I am repeating that call. Precious taxpayer resources cannot be wasted on high-tech speculation that will yield little or no benefit for the United States. The nuclear power industry has already written off the United States and looked toward Asia as a more likely target for sales of the reactors. Westinghouse has concluded that China is one its most likely targets for the AP-600. Mr. Chairman, this should not be the goal of a taxpayer-funded program.

The first-of-a-kind-engineering program, having fulfilled its mission, is nothing more than corporate welfare. Not only is there no demonstrable domestic market for these reactors, recipient companies have not targeted the U.S. as a market. Neither the taxpayers nor America's energy industry will benefit from this program. It should now accept its achievement and cease to exist.

On April 10th, I sent a letter the Secretary of Energy, urging her to end this program. Not only was there no response, the Administration requested $40 million for the first-of-a-kind engineering program. DOE has met its goal of certifying two reactors, although it is unlikely either will ever see domestic use. Instead of spending more money, DOE should focus on cost recovery.

The 104th Congress has eliminated archaic programs like the Interstate Commerce Commission (ICC) and the National Tea Board. These programs were so outdated and unnecessary, members of Congress could no longer defend their funding. Please, Mr. Chairman, don't allow the ALWR become the next ICC. Prove to taxpayers that the bold goals of this Congress to balance the budget are serious by eliminating programs that are no longer necessary, including the ALWR.

This concludes my testimony. I will be glad to answer any questions you may have.

Chairman ROHRABACHER. Mr. Bayne.

STATEMENT OF MR. PHILLIP BAYNE, CHIEF EXECUTIVE OFFICER, NUCLEAR ENERGY INSTITUTE, WASHINGTON, DC

Mr. BAYNE. Thank you, Mr. Chairman.

The Nuclear Energy Institute welcomes this opportunity to provide its prospective on nuclear R&D in the United States. I would like to thank you and the rest of the Subcommittee for setting aside this time to examine this matter of such strategic importance. The decisions of this Committee will determine how well our nation is positioned in the future to meet the energy and environmental challenges that we face.

I believe that energy policy and environmental policy are intertwined. I don't think that we can consider energy needs and future development without also considering the environmental consequences. The potential problems posed by global warming and greenhouse gas emissions do not recognize national boundaries. Therefore, we cannot concentrate only on domestic energy and environmental policy.

The history of energy policy in this country demonstrates that we are not very skilled at predicting the future. In fact, history shows that the common wisdom about energy trends or energy policy was wrong more often than it was right.

In the 1970's and early 1980's, expert opinion held that oil prices would escalate indefinitely and that we were running out of natural gas. This led to a massive program to produce synthetic oil and gas from coal and place strict limits on natural gas use. Although they appeared to make sense at the time, these policies now seem quite ludicrous.

The common wisdom today holds that world oil markets are quiet and stable, that the United States has ample supplies of electricity and that satisfying future electricity requirements in the United States and around the world will not be a problem.

Let me suggest that the common wisdom today may be just as wrong as it was in the 1970's and 1980's.

World oil demand is catching up to supply. Oil consumption in the United States, Europe and Japan has crept back to its highest level since 1979. The Energy Information Administration now expects U.S. dependence on oil imports to reach as high as 70 percent of demand by around the year 2000.

Oil demand in the emerging economies of Asia is growing at about five percent a year, and the Middle East, the world's largest source of supply and proven reserves, is as unstable politically as it ever has been.

Meeting U.S. electricity requirements will not be easy. One recent analysis shows that the United States will need an additional 225,000 megawatts of new generating capacity by the year 2010. That's a 28-percent increase over existing capacity.

Worldwide energy supplies must double or maybe even triple in the next 50 years to keep pace with population growth and economic growth. Today about six billion people live on this planet. Almost two billion of them have no access to electricity and about one billion of them have no access to commercial energy in any form, not even gasoline or diesel fuel. In about 50 years this planet will be home to 10 billion people.

There is an unbreakable connection between energy supply and economic growth. Underdeveloped nations, in many cases using fossil fuels, will increase their energy far more rapidly than the industrialized economies.

Imagine the environmental impact of this exponential growth in fossil fuel consumption around the world, and the United States will not be insulated from this problem.

In this uncertain and potentially dangerous climate, a robust U.S. R&D program is essential. A balanced energy technology development program, including nuclear energy R&D, is strategic insurance against the unpleasant shocks that may await us in the future.

As you know, America's 110 nuclear power plants are this nation's second largest source of electricity and supply about 20 percent of our electric power. Nuclear energy has supplied over 40 percent of all the new electricity required by the American people since 1973. Nuclear energy has allowed the nation's electric utility sector to virtually eliminate its dependence on imported oil. Our nuclear power plants will make by far the largest contribution of any technology toward meeting our year 2000 goal of reducing greenhouse emissions. As you know, when we make electricity using nuclear energy there is no air, water or soil pollution.

If we were forced to replace our nuclear power plants with coal and oil, this nation would pump an additional 140 million metric tons of pollution into the atmosphere every year, approximately the amount of carbon absorbed every year in this country by trees, plants and the soil.

Worldwide nuclear energy provides 17 percent of the electricity supply and avoids the emission of more than 450 million metric tons of carbon every year.

Nuclear energy is an essential component of any sound strategy to address the energy and environmental challenges facing the nation and the world. Without continued development of nuclear energy, any environmental gains we have achieved in this country and in other industrialized nations will be overwhelmed by increasing levels of pollution elsewhere in the world. In this context, continued research and development on new, improved nuclear power plant designs is not simply desirable, but it's imperative.

There is a contract between the government and the private sector dealing with this program which includes a cost-sharing arrangement. The private sector has done more than its share. It has invested $1.75 for every dollar the government has invested. In addition, the contract calls for payment to the government of royalties on the sale of these new, light water reactor designs.

Also it is estimated that approximately 5,000 jobs will be created for every time an American company sells one of these advanced plants.

This program is essential to preserving U.S. leadership in nuclear energy technology around the world. The U.S. Government's certification of the three new ALWR designs being developed under this program is critical for international sales. That certification represents an assurance to potential buyers that this technology meets the world's highest safety and operating standards.

In our view, the Department of Energy's nuclear energy R&D program requires approximately $58 million of government financing rather than the $40 million that the Administration has requested. In the context of the Department of Energy's $16.3 billion budget, $58 million is 4/10 of one percent.

Given the energy and environmental challenges facing us, Mr. Chairman, our children and grandchildren may not ask why we spent so much. They will probably ask why we spent so little.

Thank you, and I would be happy to answer any questions.

Chairman ROHRABACHER. Thank you very much.

[The prepared statement of Mr. Bayne follows:]

Statement for the Record

PHILLIP BAYNE
CHIEF EXECUTIVE OFFICER
NUCLEAR ENERGY INSTITUTE

SUBCOMMITTEE ON ENERGY AND THE ENVIRONMENT
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

May 1, 1996

Statement for the Record
PHILLIP BAYNE
Chief Executive Officer
Nuclear Energy Institute
Before The
Subcommittee on Energy and the Environment
Committee on Science
U.S. House of Representatives
May 1, 1996

Mr. Chairman, members of the subcommittee, I am Phillip Bayne, chief executive of the Nuclear Energy Institute. I am here today representing NEI's approximately 300 corporate members, including every U.S. electric utility that owns and operates nuclear power plants, as well as U.S. suppliers of equipment and services.

The Nuclear Energy Institute welcomes this opportunity to provide its perspective on civilian nuclear R&D in the United States. We firmly believe that a robust nuclear research program—including support for advanced-design nuclear power plants, for university research, and for research into the use of medical isotopes to diagnose and treat disease—is an important investment for our nation's future. My testimony will focus on the cost-shared program between the private sector and the Department of Energy to develop a new generation of advanced light water reactors (ALWRs).

Mr. Chairman, I would also like to commend you and the other members of the subcommittee for your initiative in setting aside this time to examine the role of—and need for—nuclear energy R&D in a balanced national R&D portfolio. Even though energy policy is not currently a critical national concern, this subcommittee is dealing here with matters of strategic importance. Your decisions will determine how well our nation is positioned in the future to meet the energy and environmental challenges that face us.

Let me first establish three cornerstone principles that should guide any consideration of the role of energy R&D and technology development in national energy policy.

First, I believe we can all agree that energy policy and environmental policy are essentially two sides of the same coin. They are inextricably entwined. We cannot afford to consider energy needs and the impact of energy development without also considering the environmental consequences of energy development.

Second, we cannot afford to take a myopic view of energy policy. By this I mean that we cannot think narrowly in terms of U.S. energy and environmental policy. We must develop technology and conduct national R&D programs in a broader context, recognizing that our citizens are not insulated from the effects of energy development around the world. The potential problems posed by global warming and greenhouse gas emissions do not recognize national boundaries. The United States will be affected by decisions on energy supply made around the world.

Third, the history of energy policy in this country demonstrates that we are not very skilled at predicting what the future will hold. In fact, history demonstrates that the common wisdom about energy trends or energy policy was wrong more often than it was right.

In the 1970s and early 1980s, expert opinion held that oil prices would escalate indefinitely, and that we were running out of natural gas. In response, we launched a massive program to produce synthetic oil and gas from our vast coal reserves, and placed strict limits on natural gas use. Although they appeared to make sense at the time, these policies now seem almost ludicrous.

The common wisdom today holds that world oil markets are quiet and stable, and that this orderly state of affairs will continue forever. Today's common wisdom holds that the United States has ample supplies of electricity, and that satisfying future electricity requirements will not be a significant challenge.

Let me suggest that the common wisdom today may be as wrong as it was in the 1970s and 1980s.

World oil demand is catching up to supply. Oil consumption in the United States, Europe and Japan has crept back to its highest level since 1979. The Energy Information Administration now expects U.S. dependence on oil imports to reach as high as 70 percent of demand by around the year 2000—up from about half today. Oil demand in the emerging economies of Asia is growing at about five percent a year, and will likely continue to do so for the rest of the decade. And the Middle East—still the world's largest source of supply and proven reserves—is as unstable politically as ever.

Meeting U.S. electricity requirements will not necessarily be easy, either.

The United States currently has approximately 790,000 megawatts of installed electric generating capacity. Even modest 1.5-percent-a-year growth in electricity demand will require a large amount of new generating capacity. One recent analysis shows that the United States will need an additional 225,000 megawatts of new generating capacity by the year 2010—a 28-percent increase over existing capacity. The requirements for new generating capacity in the United States rank third in the world—behind all of Western Europe and China.

We also know that world energy supply must double or maybe triple over the next 50 years to keep pace with population growth. Today, about six billion people live on this planet. Almost two billion of them, one-third of the world's population, have no access to electricity. About one billion of them have no access to commercial energy in any form—not even gasoline or diesel fuel.

In about 50 years, this planet will be home to 10 billion people.

There is an unbreakable connection between energy supply and economic growth, between energy supply and freedom from disease and hunger. Between one-quarter and one-third of the world's entire food harvest is spoiled, largely for lack of refrigeration.

Under-developed and industrializing nations, as they struggle to advance, will increase their use of energy far more rapidly than the industrialized economies. In many cases, these nations are meeting their energy needs by burning fossil fuels—principally coal. China already burns over a billion tons of coal a year—one-third more than it did just a decade ago. India's use of coal rose by two-thirds in the 1980s. South Korea's coal use more than doubled.

Imagine the environmental impact of exponential growth in fossil fuel consumption around the world. I can assure you that the United States will not be insulated from that impact.

In this uncertain—and potentially dangerous—climate, a robust national energy R&D program is not simply desirable. It is absolutely essential. A balanced energy technology development program—including nuclear energy R&D—is strategic insurance against any number of unpleasant shocks that may await us in the closing years of this century and the early years of the 21st century.

As individuals, we insure ourselves against fire, theft, natural disaster, loss of life and other risks. As a nation, we must do the same. Nuclear energy technology development will protect our citizens from the huge economic and human penalties associated with interruptions in energy supply anywhere in the world, and from the environmental consequences associated with excessive dependence on fossil fuels.

As you know, Mr. Chairman, America's 110 nuclear power plants are this nation's second largest source of electricity, and supply about 20 percent of our electric power. Nuclear energy has supplied over 40 percent of all the new electricity required by the American people since 1973. Nuclear energy has allowed this nation's electric utility sector to virtually eliminate its dependence on imported oil.

Our nuclear power plants will make by far the largest contribution of any technology toward meeting this Administration's year 2000 goals for reducing greenhouse gas emissions. If we were forced to replace our nuclear power plants with fossil-fueled generation, this nation would pump an additional 140 million metric tons of carbon into the atmosphere every year. To put that number into perspective, it is approximately the amount of carbon absorbed every year by our natural carbon “sinks”—trees and plants and soils.

Worldwide, nuclear energy provides 17 percent of electricity supply, and avoids the emission of more than 450 million metric tons of carbon every year.

Nuclear energy is an essential component of any sound strategy to address the energy and environmental challenges facing this nation and the world. Without continued development of nuclear energy, any environmental gains we achieve in this country, and in the other industrialized nations, will be overwhelmed by increasing levels of pollution elsewhere in the world. In this context, continued research and development on new, improved nuclear power plant designs is not simply desirable. It is an imperative.

Mr. Chairman, I do not wish to take the committee’s time with a detailed recitation of the unique features of the ALWR program. This program includes a cost-sharing arrangement under which the private sector invests $1.75 for every $1 invested by the taxpayer. The government investment will be repaid through royalties on the sale of these new, improved light water reactors.

The ALWR program will also preserve or create valuable high-tech jobs. We estimate that approximately 5,000 jobs will be created every time an American company sells one of these advanced plants.

This program is essential to preserving U.S. leadership in nuclear energy technology around the world. In fact, certification of the three new ALWR designs being developed under this program is essential to international sales. That certification represents an assurance to potential buyers that this technology meets the world’s highest safety and operating standards. It is an indispensable seal of approval.

In conclusion, Mr. Chairman, continuing the ALWR program will ensure that our citizens continue to reap the benefits of nuclear energy technology well into the future. Failure to continue the prudent course established in the 1992 Energy Policy Act would be a grievous strategic mistake. Future generations would record this as a failure of the energy policy process.

In our view, the Department of Energy’s nuclear energy R&D program requires approximately $64 million of government financing in the 1997 fiscal year—slightly more than the $40 million requested by the Administration. These funds would continue the ALWR program, and conduct certain research necessary to support license renewal of our operating plants, thereby preserving the benefits associated with those plants.

In the context of the Department of Energy's $16.3 billion budget request for FY97, $64 million is 0.004 percent—4 one-thousands of one percent—of the DOE budget. Given the energy and environmental challenges facing us, Mr. Chairman, our children and grandchildren will not ask why we spent so much. They will more likely ask why we spent so little.

Thank you, and I would be happy to answer any questions.

Chairman ROHRABACHER. Mr. Freedman.

STATEMENT OF MR. MATT FREEDMAN, ENERGY POLICY ANALYST, PUBLIC CITIZEN'S CRITICAL MASS PROJECT, WASHINGTON, DC

Mr. FREEMAN. Mr. Chairman and members of the Subcommittee, I thank you for the opportunity to testify today for Public Citizen on the Department of Energy's fiscal year 1997 budget request for advanced light water reactors, and I ask that my full written statement be included in the record.

Chairman ROHRABACHER. Certainly, without objection.

Mr. FREEMAN. Public Citizen urges the Subcommittee not to renew support in fiscal year 1997 for DOE's Advanced Light Water Reactor Program which funds collaboration with the Advanced Reactor Corporation to design, engineering and obtain regulatory approval for new evolutionary nuclear reactors.

Between fiscal years 1992 and 1996, DOE provided over $250 million to this consortium to assist first-of-a-kind engineering, design certification and licensing support activities. The ALWR program should be essentially complete by the end of fiscal year 1996 when DOE's contract with the Advanced Reactor Corporation for first-of-a-kind engineering expires and the two lead designs receive final design certification from the Nuclear Regulatory Commission.

The ALWR program was intended to make new reactor designs available for domestic markets. It was foreseen that American utilities would be ready to order new nuclear plants by the time that these designs were certified. But since the passage of the Energy Policy Act the domestic market situation has changed significantly and effectively eliminated the possibility of new nuclear plant orders for the foreseeable future.

Competition in the electricity sector in this country is on the horizon. States are moving to implement wholesale and retail competition while preparing to open utility service territories to aggressive companies ready to compete for utility customers by offering low-cost power. In a competitive market, utilities will no longer be guaranteed cost recovery for uneconomical generation assets making large up-front investments extremely unattractive.

Nuclear plants by their nature are capital intensive, and increasingly uncompetitive in today's low-cost electricity markets. As a result, domestic electric utilities are more averse to ordering new nuclear power plants today than at any time since the dawn of commercial nuclear power.

As of today, not one utility or company participating in the ALWR program has committed to building a new reactor in this country. Instead, the reactor vendors are setting their sights on export markets and giving up on the possibility of new domestic orders.

Even the Nuclear Energy Institute in a letter to Members of Congress last year admitted that "the ALWRs are prime candidates for orders in Southeast Asia." In fact, the first commercial advanced light water reactor, a General Electric advanced boiling water reactor supported under the First-of-a-Kind Engineering Program, began operation in Japan earlier this year.

GE has now sold at least two other ABWRs to Japanese utilities. Asea Brown Boveri's System 80-Plus, another ALWR design, was recently offered to the Taiwan Power Company in response to their international bid specification.

Instead of providing reactors for domestic markets, the ALWR program has become an export promotion subsidy for GE, Westinghouse and ABB in direct violation of the intent of the Energy Policy Act. Under EPACT, recipients of any ALWR money must certify to the Secretary of Energy that they intend to construct and operate a reactor in the United States. Based on the actions and statements of industry participants, it's clear that such a promise could not be made with a straight face. Despite the original intent to the contrary, the ALWR program is now exclusively focused on assisting reactor exports to Southeast Asia.

By the end of fiscal year 1996, the ALWR program will essentially support only one remaining design, Westinghouse's AP-600. The AP-600 is a design cursed by the persistent lack of domestic interest in new reactors as it is the only design in the program engineered specifically to meet the needs of U.S. utilities.

In the early 1990's domestic electric utilities indicated that if they were to buy new reactors that design should be mid-sized, around 600 megawatts of capacity. Intending to pursue this domestic market, GE and Westinghouse produced competing designs.

GE's design, the simplified boiling water reactor, was a participant in the ALWR program until February 29th of this year, when GE announced it was terminating all work on this reactor. In their press statement they explain that "Extensive evaluations of the market competitiveness of a 600 megawatt size advanced light water reactor have not established the commercial viability of these designs, particularly in light of the increasingly competitive nature of the electric industry throughout the world."

Well, since the Westinghouse AP-600 is exactly the same size as GE's cancelled SBWR, one must wonder about the market potential for this design. When asked by the trade publication *Nucleonics Week* about likely buyers for the AP-600, a Westinghouse spokesperson, as Mr. Schatz indicated, identified China and Indonesia as their possible markets. And, since the United States currently prohibits the export of nuclear technology to China, it raises serious questions about the propriety of DOE's support for a design that is intended for export to a banned market. As for Indonesia, many in the market view the market as a long-term prospect at best. In other words, the AP-600 has not perspective buyers either in this country or abroad.

Continuing the ALWR program would also violate authorization from the Energy Policy Act that explicitly states that design certification support should only be provided for designs that "can be certified by the NRC by no later than the end of fiscal year 1996." While the two designs due to be certified by the end of this fiscal year, the ABWR and the System 80-Plus, would seem to meet this test, the AP-600 certainly does not. The AP-600 is currently projected to receive NRC design certification by fiscal year 1998 or 1999.

But perhaps the most egregious aspect of the ALWR program is DOE financial support for design certification approval from the

NRC. Vendors seek NRC certification because it represents a seal of approval that can be used to market their designs abroad. In contrast to all other NRC oversight activities, which are supported entirely by user fees, companies seeking generic design certification have their fees subsidized by the Department of Energy.

This regulatory subsidy is quite astonishing. One government agency paying for another agency's licensing fees on behalf of profitable corporations like General Electric, Westinghouse and Asea Brown Boveri. There would seem to be no precedent for such an arrangement within any other DOE program, and its existence raises serious questions about the propriety of funding NRC license reviews with taxpayer dollars.

The Advanced Light Water Reactor Program is a textbook example of corporate welfare. The industry receiving the support is mature, wealthy and fully able to invest its own money in bringing new products to market. GE, for example, had $60 billion in 1994 revenues, and Westinghouse had $8.8 billion in revenues that same year. I find it extremely hard to believe that these companies are completely dependent upon government support to develop new designs that according to the industry are certain to have substantial market potential.

I will submit the rest of my testimony and would be happy to answer any questions that the Committee has.

[The prepared statement of Mr. Freedman follows:]

Public Citizen

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Joan Claybrook, President

TESTIMONY OF

MATTHEW FREEDMAN

ENERGY POLICY ANALYST

PUBLIC CITIZEN'S CRITICAL MASS ENERGY PROJECT

TO THE

HOUSE SCIENCE COMMITTEE

ENERGY AND ENVIRONMENT SUBCOMMITTEE

MAY 1, 1996

Ralph Nader, Founder

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Mr. Chairman and members of the Subcommittee, I thank you for the opportunity to testify today for Public Citizen on the Department of Energy's Fiscal Year (FY) 1997 budget request for Advanced Light Water Reactors. I ask that my full written statement be included in the record.

Introduction and Summary

Public Citizen urges the Subcommittee not to renew support in FY'97 for DOE's Advanced Light Water Reactor (ALWR) Program, which funds collaboration with the Advanced Reactor Corporation to design, engineer and obtain regulatory approval for new evolutionary nuclear reactors. Between FY'92-96, DOE provided over $250 million to this consortium to assist "first-of-a-kind engineering" (FOAKE), design certification and licensing support activities. The ALWR program should be essentially complete at the end of FY'96 when DOE's contract with the Advanced Reactor Corporation for FOAKE expires and the two lead designs receive final design certification from the Nuclear Regulatory Commission (NRC).

The ALWR program has strayed significantly from its original purpose, which was to help industry develop and certify reactors for domestic markets. As proposals to open domestic electricity markets to competition proceeded over the last several years, the ALWR program transformed into an export assistance effort as vendors looked to East Asia and other foreign markets. But some of these designs are not suited to foreign utilities, and the recent cancellation of one ALWR design spells trouble for the remaining reactor, which suffers from similar market problems.

Congress, in the Energy Policy Act of 1992, intended the ALWR program to be a five-year effort that would end in FY'96 and placed a number of limitations in the authorization language. By requesting more money for the ALWR program, the Department of Energy is attempting to distort the original intent of EPACT and retain a subsidy program without regard to its utility or value to taxpayers.

This program is a textbook example of corporate welfare. Companies receiving money from DOE for new reactor development include Westinghouse, General Electric (GE) and Asea Brown Boveri (ABB). These companies receive money not only for engineering work, but also to cover user fees charged by the NRC for the design certification, or generic licensing, of new reactor technologies. This type of regulatory subsidy is unique within DOE and totally without justification.

Extending the ALWR program would send a strong message that subsidies to large, profitable corporations are exempt from scrutiny while other programs in the federal budget are cut to reach overall spending targets. The industry receiving this support is mature, developed and profitable and should be fully able to invest its own money in bringing new products to market. Though the industry claims that all costs incurred by DOE are subject to recovery upon the sale of ALWRs, there are serious concerns that many costs will never be recovered and most sales are not subject to this provision.

With reductions in federal energy R&D already underway, this committee needs to make choices about the kind of energy research it wants to support. If you look to the House Budget resolution, consult public opinion, or consider the views of public policy, consumer, taxpayer and environmental groups, continuation of this program would be impossible to justify.

EPACT's Domestic Focus Undermined by Competition

The ALWR Program was intended to make new reactor designs available for domestic markets. It was foreseen that American utilities would be ready to order nuclear plants by the time these new reactors were certified. But since the passage of the Energy Policy Act (EPACT), the domestic market situation has changed significantly and effectively eliminated the possibility of new nuclear plant orders for the foreseeable future.

Competition in the electricity sector is on the horizon. States are moving to implement wholesale and retail competition while preparing to open up utility service territories to aggressive companies ready to compete for utility customers by offering low-cost power. In a competitive market, utilities will no longer be guaranteed cost recovery for uneconomical generation assets, making large, up-front investments extremely unattractive. Nuclear plants by their nature are capital-intensive and increasingly uncompetitive in today's low-cost electricity market. As a result, domestic electric utilities are more averse to ordering new nuclear power plants today than at any time since the dawn of commercial nuclear power.

No new nuclear orders have been placed since 1978, and this year's survey of utility CEOs performed by the Washington International Energy Group found that 89% said that their company would never consider ordering a nuclear power plant, and only 8% believed that there would ever be a resurgence of nuclear power. The survey concluded that "the sharp decline in the number of respondents expecting a resurgence of nuclear power is significant. It leaves little hope that new nuclear generation will remain an option for utilities in a time frame that has any practical significance."

Industry Abandons Domestic Markets, Looks to Exports

As of today, not one utility or company participating in the ALWR program has committed to building a new reactor in this country. Instead, the reactor vendors are setting their sights on export markets and giving up on the possibility of new domestic orders. Even the Nuclear Energy Institute (NEI), in a letter to members of Congress last year, admitted that "the ALWRs are prime candidates for orders in Southeast Asia." NEI's newsletter, *Nuclear Energy Insight*, wrote that "all three [ALWR] designers see their most immediate opportunities for selling their designs in Pacific Rim countries."

In fact, the first commercial Advanced Light Water Reactor, a General Electric Advanced Boiling Water Reactor (ABWR) supported under "first-of-a-kind-engineering", began operation in Japan earlier this year. GE has now sold at least two other ABWRs to Japanese utilities. Asea Brown Boveri's System 80+, another ALWR design, has had several design improvements incorporated into new South Korean reactors and was recently offered to the Taiwan Power Company in response to their international bid specification.

Instead of providing reactors for domestic markets, the ALWR program has become an export promotion subsidy for GE, Westinghouse and ABB in direct violation of the intent of the Energy Policy Act. Under EPACT (42 USCA §13493), recipients of any ALWR money must certify to the Secretary of Energy that they intend to construct and operate a reactor in the United States. Based on the actions and statements of industry participants, it is clear that such a promise could not be made with a straight face. Despite original intent to the contrary, the ALWR program is now focused on assisting reactor exports to Southeast Asia.

Westinghouse's AP-600 and General Electric's SBWR

By the end of FY'96, the ALWR program will support only one remaining design, Westinghouse's AP-600. The AP-600 is a design cursed by the persistent lack of domestic interest in new reactors as it is the only design in the program engineered specifically to meet the needs of U.S. utilities. In the early 1990's domestic electric utilities indicated that if they were to buy new reactors, the designs should be mid-sized -- around 600 Megawatts of capacity. Intending to pursue the domestic market, GE and Westinghouse produced competing designs. GE's design, the Simplified Boiling Water Reactor (SBWR), was a participant in the ALWR program until February 29 of this year, when GE announced that it was terminating all work on the reactor. In their press statement, they explain that "GE Nuclear Energy is redirecting the focus of its SBWR technology programs to plants of 1000 MWe or larger...extensive evaluations of the market competitiveness of a 600 MWe size Advanced Light Water reactor have not established the commercial viability of these designs, particularly in light of the increasingly competitive nature of the electric industry throughout the world."

Since the Westinghouse AP-600 is exactly the same size as GE's cancelled SBWR, one must wonder about the market potential for this design. When asked by the trade publication *Nucleonics Week* about likely buyers for the AP-600, a Westinghouse spokesperson identified China and Indonesia as possible markets. The United States currently prohibits the exports of nuclear technology to China, raising serious questions about the propriety of DOE support for a design that is intended for export to a banned market. As for Indonesia, many in the industry view the market as a long-term prospect at best.

In other words, the AP-600 has no prospective buyers. Though Westinghouse makes grand claims about international support for this design, similar statements were made for General Electric's now-cancelled SBWR. Before its termination, the Nuclear Energy Industry's *1995 Strategic Plan for Building New Nuclear Power Plants* asserted that the SBWR had "significant worldwide support by participants from 41 organizations from 11 countries [that] reflects the broad interest in this design concept...testing of the SBWR is underway in the United States, Switzerland, Italy and Japan." This "worldwide support" evidently was not enough to convince General Electric that continuing work on their reactor would lead to any orders.

ALWR Program Due to End In FY'96

Continuing the ALWR program would violate authorization from the Energy Policy Act explicitly stating that design certification support should only be provided for designs that "can be certified by the [Nuclear Regulatory] Commission by no later than the end of fiscal year 1996." While the two designs due to be certified by the end of this fiscal year, the ABWR and System 80+, would seem to meet this test, the AP-600 certainly does not. The AP-600 is currently projected to receive NRC design certification in FY'98 or '99.

During floor debate last year on an amendment to terminate further support for the ALWR program, Energy & Water Appropriations Subcommittee Chair John Myers (R-IN) acknowledged that the program was scheduled to finish by the end of FY'96. In defense of continued funding, he said that "it would be a terrible mistake today for our government to renege on the commitment of the fifth year of a five-year contract when we already have four years invested." One year later, the industry and DOE want a sixth year of funding for this five-year program.

Another section of EPACT makes clear that the program is meant to exist for a limited period by stating that "no entity shall receive assistance under this subsection for a period greater than 4 years." A memo from DOE's General Counsel to Terry Lash, Director of the Office of Nuclear Energy, acknowledges that continuing to support this program "would come under the EPACT section 2123 (b)(4)(B) cap on assistance on or about October 24, 1996, the date of EPACT's enactment."

Although DOE's General Counsel claims that the Atomic Energy Act provides sufficient authority to continue ALWR activities, Congress should view such an interpretation with skepticism. The language in EPACT is not an accident, but rather was a purposeful effort to instruct DOE on how the program should be conducted and to place limitations on federal support by firmly establishing end dates and disqualifying designs that would not be complete by that time. If Congress decides to continue this program over the next several years, it sends a clear message that authorizing language in major legislation is irrelevant and that programs running behind schedule can expect endless support regardless of the program's original intent.

Design Certification Funding Is Unwarranted and Unprecedented

Perhaps the most egregious aspect of the ALWR program is DOE financial support for design certification approval from the NRC. Vendors seek NRC certification because it represents a 'seal of approval' that can be used to market their designs abroad. In contrast to all other NRC oversight activites, which are supported entirely by user fees, companies seeking generic design certifcation have their fees subsidized by DOE. This regulatory subsidy is quite astonishing -- one government agency paying for another agency's licensing fees on behalf of the profitable corporate giants General Electric, Westinghouse and Asea Brown Boveri.

There would seem to be no precedent for such an arrangement within any other DOE program, and its existence raises serious questions about the propriety of funding NRC license reviews with taxpayer dollars. In its February 29, 1996 testimony to the House Energy and Water Appropriations Subcommittee, Westinghouse requested $10 million for this effort in FY'97, $7 million of which would be passed on to the NRC to cover user fees. It is unfathomable that a company like Westinghouse should expect a government handout to pay the costs of NRC regulatory approval.

ALWR Is A Textbook Case of Corporate Welfare

The Advanced Light Water Reactor program is a textbook example of corporate welfare. The industry receiving this support is mature, wealthy and fully able to invest its own money in bringing new products to market. General Electric, for example, had $60 billion in 1994 revenues. Westinghouse had $8.8 billion in revenues the same year. I find it hard to believe that these companies are completely dependent upon government support to develop new designs that, according to the industry, are certain to have substantial market potential.

House Budget Resolution Prohibits Support For ALWR Program

The 1996 House Budget Resolution laid out strict criteria for the funding of Energy R&D projects in the form of a six point test. If the Subcommittee chooses to apply these criteria in the FY'97 authorization bill, funding the ALWR program would be inconceivable. The following two tests identified by the budget resolution are appropriate to review:

> *"Federal government efforts should focus on long-term, non-commercial R&D with a potential for significant scientific discovery, leaving economic feasibility and commercialization to the marketplace."*

> *"The federal government should avoid funding research in areas that are receiving or should reasonably expect to receive funding from the private sector, such as evolutionary advances or incremental improvements."*

As for the first test, it should be obvious that this program is near-term, commercial R&D that specifically looks to assist companies with the economic feasibility and commercial potential of their designs. The ALWR program fails the second test because, as stated previously, the companies receiving money from DOE are extremely profitable and are fully able to fund their own engineering, licensing and promotion. If these companies cannot be expected to fund their own product development, then I would wonder which industries do not need government support. Furthermore, the designs under development are referred to by the industry itself as "evolutionary" and the advances are described in its own literature as improvements on existing reactor technologies.

Problems with Cost Recovery Provisions

The recipients of ALWR money assert that renewing support in the coming years does not burden taxpayers because the sales of advanced reactors will generate royalties earmarked for repayment of all government funds invested. In addition, letters sent to members of Congress by the Nuclear Energy Institute have warned that ending support would endanger the cost recovery provisions of DOE's agreement with the industry.

Any concerns on the latter point are completely unfounded. Under the terms of the cooperative agreement between DOE and the Advanced Reactor Corporation, the government is entitled to recover program costs from sales of ALWRs sold even if the program is terminated ahead of schedule.

In terms of prospects for cost recovery from existing DOE investments, there are disturbing signs that the industry and DOE are not acting in good faith and that some funds will likely never be repaid. As stated earlier, General Electric has sold at least three units of their ABWR to Japanese utilities, one of which is already operating. According to the Nuclear Energy Institute's *Nuclear Energy Insight* newsletter (February, 1996), the first unit sold to Tokyo Electric Power Company "is a clone of the GE-designed ABWR that received final design approval from the US Nuclear Regulatory Commission in 1994." Despite the sale of this unit and others to Japan, DOE admits that it has not received any money from General Electric as required under the cooperative agreement.

Moreover, the cooperative agreement states that sales of reactors to utilities that are members of the Advanced Reactor Corporation (ARC) are not subject to royalties for cost recovery. In other words, even if a rosier domestic market emerged and every U.S. utility member of the ARC ordered ALWRs, taxpayers would receive no return on their investment.

Additionally, DOE has provided approximately $50 million to General Electric for its SBWR design that the company recently decided to abandon. It is not clear that any of this money can ever be recovered. Given the poor market prospects for Westinghouse's AP-600, cost recovery would seem to be unlikely in the near-term and doubtful, at best, over the next decade.

Strong Public Opposition to Government Support for Light Water Reactors

Public opinion on energy R&D priorities has been consistent in surveys taken over the past decade. In poll after poll, Americans say that while they support funding emerging energy efficiency and renewable energy technologies, the federal government should not be assisting mature, profitable industries to conduct RD&D on nuclear power and fossil fuels.

The most recent survey demonstrates that these preferences are strongly held. Republican pollster Vince Breglio, who formerly worked for the Reagan and Bush campaigns, polled 1,000 registered voters in December, 1995. When asked which DOE programs should be subject to funding cuts first, nuclear power was chosen by the largest number of respondents. In another question, over 70% of respondents opposed DOE support for developing a new generation of nuclear reactor technologies. This question is noteworthy because it specifically describes the ALWR program and reflects an extraordinarily high level of opposition. In analyzing the results, pollster Breglio writes that "large majorities, from two-thirds to three-fourths among political and demographic subgroups, oppose federal funding of a new generation of nuclear power plants."

A Wide Array Of Organizations Oppose New ALWR Funding

Over the last two years, a wide array of consumer, environmental, public policy and taxpayer organizations have supported elimination of the ALWR program through their endorsements of documents like the "Green Scissors Report", "the Dirty Dozen" and in letters to Congress urging termination. These groups include Public Citizen, the National Taxpayers Union, Citizens Against Government Waste, the CATO Institute, Concord Coalition, Citizens for a Sound Economy, the Progressive Policy Institute, Friends Of the Earth, U.S. Public Interest Research Group, the Safe Energy Communications Council, Sierra Club, and Taxpayers for Common Sense. These groups represent a diverse spectrum of ideology and interests, demonstrating that there is a broad consensus for terminating additional funding for the ALWR program.

Last October, Senators McCain (R-AZ), Feingold (D-WI), Thompson (R-TN) and Kerry (D-MA) introduced a bipartisan corporate welfare elimination package that included the ALWR program. In his statement on the plan, Senator McCain called for the ALWR program, among others, to be ended because "corporate pork wastes resources, increases the deficit, distorts markets and has no place in a free market economy or in a budget where we are asking millions of Americans to sacrifice for the good of future generations."

In the House, Congressman Obey (D-WI) introduced an amendment to eliminate this program as part of the Fiscal Year 1996 Energy and Water Appropriations Bill. Though this amendment failed to pass, 191 members voted to terminate ALWR funding.

Conclusion

The nuclear power industry has received extensive federal support over the past five decades, amounting to $47 billion in real terms (or over 50% of all energy R&D), for the development of new reactor technologies. It is now time to end subsidies to this industry and allow the technology to compete on its own merits in the marketplace. The Advanced Light Water Reactor program has moved well beyond its original intent of developing reactors for domestic use and become an export promotion effort funded by the taxpayers. The recipients of this money are large companies and should be asked to fully support their own product development as the government cuts back on support for energy research. If this Congress is serious about cutting corporate welfare programs out of the budget, the ALWR program should be among the first items on the list.

Chairman ROHRABACHER. Thank you, Mr. Freedman, and thank you to the whole panel. We now will proceed with some questions from members of the Committee.

Let me ask you, Mr. Freedman, off the bat, are you just opposed to all nuclear energy? You're saying this is a bad deal, but in reality you're opposed to all nuclear energy; is that right?

Mr. FREEMAN. Public Citizen does support the phase-out of existing nuclear reactors over time to be replaced by efficiency and renewable energy technologies.

Chairman ROHRABACHER. That does not undermine the validity of the statements that you've made and the points that you've made.

Mr. FREEMAN. I think it makes us experienced critics of the industry.

Chairman ROHRABACHER. All right, good.

[Laughter.]

Mr. Schatz, your organization basically wants to phase out most government programs, doesn't it?

Mr. SCHATZ. Not most, Mr. Chairman.

Chairman ROHRABACHER. That makes you a good critic of government in general.

Mr. SCHATZ. We've certainly been accused of that on occasion, and of course we always have the space station/superconductor debate. We look for just simply better ways to spend the taxpayers' money. If DOE has a budget and they can squeeze everything in, that's fine, but we also would like to see them work, and certainly in this case it's not something that seems to be working the way it was intended.

Chairman ROHRABACHER. All right. Well let me ask a couple of questions.

Dr. Lash, on February 27th, General Electric announced it would terminate the Simplified Boiling Water Reactor Program. How much did the taxpayers invest in that program and what happened to the money?

Dr. LASH. The investment from the Department of Energy in the Simplified Boiling Water Reactor Program is approximately $48 million.

Chairman ROHRABACHER. When did we give them that $48 million?

Dr. LASH. Well that's over a period of years, including an initial payment in the current fiscal year.

Chairman ROHRABACHER. And how much was that initial payment?

Dr. LASH. The initial payment was about $800,000 I believe.

Chairman ROHRABACHER. So we gave them $800,000 basically just a little while ago, a couple of months ago, and on February 27th they announced that they would terminate the program.

Dr. LASH. Well let me say that we are in negotiations and discussions with General Electric, first of all, to understand what the meaning was of their announcement. I've learned somewhat painfully over the years in government service, first in the State of Illinois and then here, that you can't always take literal words in a press release or in press accounts as to what is happening. So I'm not accepting that I understand or that GE has fully explained its position via press release or news accounts.

We have a contract with General Electric, and there are obligations for both the government and General Electric under that contract, and I can assure you we will do everything we can to make General Electric live up to its obligations under the contract, and we will not make any further payments, and we had expected to, until this matter is clarified.

Now as I understand the initial position of General Electric, it's not a criticism of the basic technology of the simplified boiling water reactor that they're abandoning. Rather, in looking at their market, General Electric's market, they have decided that a larger version of this technology would be more appropriate to pursue rather than the mid-sized.

Chairman ROHRABACHER. So they're saying that the AP-600 smaller reactor is a bad investment?

Dr. LASH. Well, no. What they're saying is for their market it is not the right size, as I understand it.

Chairman ROHRABACHER. Isn't that what I just said?

Dr. LASH. No. Westinghouse probably has a different marketing plan and a somewhat different market in mind than General Electric. General Electric is highly concentrated currently in the Japanese market. Japan being a small country physically puts a great deal of premium on sites. In fact, they have a problem in locating new sites for new nuclear power plants. That puts a great deal of emphasis on maximizing the energy intensity of those sites, which I think would drive you towards a larger reactor as opposed to a smaller reactor. A different set of circumstances applies to the United States and other large countries, such as China, which has expressed a very serious interest in the AP-600.

Chairman ROHRABACHER. Well of course large countries like China necessarily don't have more room. I mean, for example, a lot of these other countries may have on a map more space, but if you take a look at them their populations are very crowded and they have exactly the same problems that Japan might have. But, anyway, that would be for General Electric or Westinghouse to decide.

By the way, what is preventing Westinghouse from issuing the same kind of press release and putting this in that same kind of position after they've been taking more of our money this year?

Dr. LASH. Well Westinghouse has invested money in the AP-600 as has the Advanced Reactor Corporation which gets contributions from several utilities that are interested in this technology. In fact most of the money that is invested in the program is not government money, but it's rather industry money.

But is there a possibility or theoretically speaking or hypothetically speaking that Westinghouse could do something that would be adverse to the program? I guess the answer is yes, but as we all know it's difficult to answer hypothetical questions. I see no evidence. I've received no communication from Westinghouse or others that they have any similar intent of going to a larger sized reactor.

Chairman ROHRABACHER. Of course if they're putting their own money into it all along rather than having this "partnership" with the taxpayers, they would be less likely to back out on something that they had more invested in. Wouldn't that be true?

Dr. LASH. Well I don't know that I agree with that. I think these judgments are based on market analysis and future electrical demand and political considerations about the opportunities to site new nuclear power plants, and I think those macro-considerations would override the issue of whether the government had participated in funding or not.

Chairman ROHRABACHER. Mr. Freedman is just itching to say something. So go right ahead, Mr. Freedman.

Mr. FREEMAN. Well I would like to address a couple of the issues that Dr. Lash raised.

First of all, it sounds like the Department of Energy is more interested in commercializing the SBWR than GE itself based on the nature of the testimony today, and I would question the idea that there are different markets for the AP-600 and the SBWR.

They're designs of roughly the same size, and my understanding is that they were both developed for sale to domestic utilities, and when the domestic market picture began to look particularly unpromising it became clear to GE at least that they should focus their efforts on exports. Southeast Asian countries have expressed interest for extremely large reactors and not mid-sized reactors, which is why they have focused on their advanced boiling water reactor, which is about 1350 megawatts. So I think that it's really not true that there are different markets.

As far as the Westinghouse AP-600 goes, they were designing this for American utilities that now have no interest in buying the reactor. And furthermore the reason that Westinghouse will continue to be interested in this program is because they're next in line to receive the bulk of the funding.

Chairman ROHRABACHER. That's true.

Mr. Bayne, if you want to get in on this go right ahead.

Mr. BAYNE. Yes, I would. I've heard a lot of people here say that because nobody has ordered a nuclear power plant that no one is interested in a nuclear power plant, and that's a great leap of faith I think because prior to my present job I was president of a utility; and as the president of a utility I put money into ARC, and there were 15 other utilities that did that.

Now there are only 44 utilities in the United States that own nuclear power plants, and 16 of the 44 put money into that. Utility executives are not known for their desire to throw money around, and that to me leads me to believe that the 16 people who put money into that program were interested in it.

Now I hear people say "Well, nobody has ordered one, and therefore nobody is interested." Well as a utility executive, I can tell you you don't go around telling people, "Well, I'm going to order this, that or the other thing." What you do is you go and look at what is available, whether it's a coal plant or a hydro plant or a nuclear plant, and you make a decision based on your area and your company's needs, and you take it to your board and you say, "Hey, I think we ought to build this, that or the other thing."

It's like playing poker, you don't show your cards before you're ready to show your cards. So I don't think anybody is going to order one of these until the day they announce it in the press that they've ordered one. That doesn't mean to me that there is no interest in this country in these power plants.

Chairman ROHRABACHER. But there is a situation in the country today as compared to years ago where it's much more difficult to get the permits perhaps because of the activism of a lot of people like Mr. Freedman and others who may or may not be correct in their visceral opposition to nuclear energy, but still they are part of a democratic society and part of the process that makes it work and have to be calculated into the formula as to whether something is the right direction to go.

Doesn't that seem to indicate that the nuclear energy plants are not being pursued because now with all of these things under consideration it's not a viable alternative?

Mr. BAYNE. Well that's exactly the reason that the 16 utilities put their money into this program so that they could get a fully-certified design that they could buy off the shelf knowing that they could get the permits necessary to build it, and also to know that it could be built in four years as an ABWR was built in Japan in four years at a predicable cost. That's what we were after. We were after predictable cost, predictable schedule and a licensable power plant. You're right, if we had a non-licensable power plant that could be built in 20 years instead of four, nobody would buy one. But we tried to set up this program so that we could have a plant that would be purchasable by people who were interested.

Chairman ROHRABACHER. I'm going to move on to Mr. Roemer and let other people get into the discussion now.

Mr. Roemer.

Mr. ROEMER. Thank you, Mr. Chairman.

I've been a supporter of the Advanced Light Water Reactor Program, but my position has been to support it up through the certification process, and Dr. Lash, certainly Mr. Schatz and Mr. Freedman make some pretty good points in terms of their accusations that we have a diminishing budget and we have to make some tough choices in spending cuts. They also used the term "corporate welfare."

Dr. Lash, how do you respond to this, and if you could give me a very concise and specific justification for continuing this program after the certification process?

Dr. LASH. Well in terms of new nuclear power plants, there is only one activity after certification, which is the First-of-a-Kind Engineering Program for the AP-600. And I agree with you that it's very important to bring to a conclusion in the near future the certification program. It's a modest investment based on all the work that has taken place and we should bring that to a successful conclusion within a year.

With regard to the First-of-a-Kind Engineering Program on the AP-600, the AP-600 represents the most advanced technology in the world today for passively cooling light water reactors. It is the reactor in which there is a great deal of interest around the world. I believe the United States has a technology lead here of some significant amount, and I believe it is in our national interest to complete that First-of-a-Kind Engineering Program for the AP-600 so that the reactor is available for the future both in this country and in other countries. We leverage our dollars with industry. It is not a big investment into the future, and I think as part of a multifaceted approach to ensuring the electrical energy supply, it is well worth the investment.

Mr. ROEMER. Dr. Lash, moving on to another topic, I would like to know specifically what research does the Nuclear Energy Program fund concerning victims of the Chernobyl accident, and could you bring me up to date concerning Mr. Yeltsin and President Clinton's meeting last week in Moscow? Did this change the course of this research in any way, and did it bring any new things to light?

Dr. LASH. The Office of Nuclear Energy is involved in the Chernobyl nuclear power plant and in trying to support the G7 effort to bring that reactor to as swift a complete shutdown as possible, and in the meantime upgrading its safety for the next few years while it will probably operate. However, the Office of Nuclear Energy is not directly involved in issues related to the victims of that accident. There is work elsewhere in the Department with which I'm not intimately familiar dealing with radiation exposures and the consequences of that, and Mr. Peter Brush probably can address that better than I can.

With regard to the Summit, I think the Summit was very important in reinforcing, among other things, the importance of the commitment from Ukraine to shut down the Chernobyl nuclear power plant by the year 2000. We need to continually reinforce this objective because there are those in Ukraine who would like to see that power plant continue to operate for longer than I think it is wise.

But there are other important outcomes from the Summit dealing with trying to control the possibility of nuclear smuggling, getting a commitment from Russia to join an International Liability Convention on Nuclear Energy and to ratify the Nuclear Safety Convention, which is a very important step in bringing the countries of the former Soviet Union, including Russia, into an international nuclear safety regime.

I think those were the major outcomes from that Summit, and we can consider them to have been quite helpful in our efforts to improve nuclear safety in the former Soviet Union.

Mr. ROEMER. Dr. Lash, I just want to commend your concentration to answering that question during the course of six bells ringing and 18 buzzers and beepers going off at the same time. I think you were remarkably composed there.

If you would do me a favor, Dr. Lash, and for the Committee, if you would please respond to me in writing with an answer to that question.

My understanding from staff is that Peter Brush said that they did not do anything in addition to what you may have implied that they do, and if I could just find out from the Department in a more comprehensive way under your jurisdiction as well as other jurisdictions what programs do help the victims of Chernobyl and in writing what happened at the Summit, I would certainly appreciate that, and I know the Committee would, too.

Dr. LASH. I would be happy to respond in writing, and I am aware that there is activity with regard to assessing the radiation effects on victims of the Chernobyl accident.

[The following response was received for the record:]

COMMITTEE: HOUSE SCIENCE COMMITTEE
SUBCOMMITTEE ON ENERGY
AND ENVIRONMENT

DATE: MAY 1, 1996

WITNESS: Dr. Terry R. Lash
PAGE: 100-102, LINE 2202-2263

INSERT FOR THE RECORD

Department of Energy Programs to Aid Chornobyl Victims and Information on Moscow Nuclear Safety and Security Summit

The Nuclear Safety and Security Summit was held in Moscow on April 19-20, 1996. The Summit, which was initiated by Russia, was attended by the United States, France, Germany, Great Britain, Italy, Canada, and Japan. Ukraine was invited to participate in a limited set of discussions specifically relating to Chornobyl and trafficking of nuclear materials.

The following topics were discussed by the leaders of the nine countries and are specifically addressed in the official Summit declaration and associated papers (attached):

- nuclear safety, including nuclear liability and energy sector strategies;
- nuclear waste management, including a ban on ocean dumping and development of an international convention on radioactive waste; and
- nuclear material security, including an action plan to combat illicit trafficking of nuclear material, nuclear material protection, control and accounting, and fissile material management.

Highlights from the Summit discussions include the following:

* The government leaders issued a statement committing them to conclude and sign a Comprehensive Test Ban Treaty by September 1996. The leaders agreed that this treaty must prohibit "any nuclear weapon test explosion or any other nuclear explosion," which is consistent with President Clinton's decision to negotiate a true zero yield test ban.

* Russia agreed, at President Clinton's urging, to take steps to persuade China to agree to the Comprehensive Test Ban Treaty.

* Russia stated that it would come into full compliance with the London Dumping Convention this year (i.e., adherence to the 1993 amendment banning the disposal at sea of all radioactive wastes or other radioactive matter, including low-level radioactive waste).

- Russia announced that it had "adopted" the Convention on Nuclear Safety (a legal approach which does not require parliamentary action and official ratification).

- Ukraine's President Kuchma reiterated his commitment to shut Chornobyl by the year 2000, and indicated that Unit 1 may be closed as early as this year. The leaders agreed that a meeting should be held in early 1997 to discuss solutions for the problem of the sarcophagus covering damaged unit 4.

- The group adopted the Action Plan on Illicit Trafficking, which includes increased cooperation on law enforcement, intelligence gathering, and information sharing.

- At the suggestion of Great Britain's Prime Minister John Major, it was agreed that the P-8 Nonproliferation Working Group and the G-7 Nuclear Safety Working Group should remain in existence. (These groups were responsible for developing all the official Summit documents.)

- It was agreed to hold an experts meeting in October 1996 to examine options for fissile material management and disposition.

COMMITTEE: HOUSE SCIENCE
DATE: MAY 1, 1996
WITNESS: TERRY LASH
PAGE 100 LINE 2209
PAGE 102 LINE 2263

Insert for the Record

DOE-sponsored Studies of Victims of the Chernobyl Accident

The Office of Environment, Safety and Health funds the Department's five ongoing or planned studies related to the victims of the Chernobyl accident. The Departments funding for FY 1996 is $ 1,832,000 and planned funding for FY 1997 is $ 1,500,000. As indicated in the summary below, U.S. support for these studies is also provided by the Nuclear Regulatory Commission (NRC) and the National Cancer Institute (NCI). NCI is responsible for the design and implementation of these studies. Also, as indicated below, support for these studies is provided by the Governments of Belarus, Ukraine, and France.

A. Belarus: Childhood Thyroid Study

Objectives: To develop risk estimates for thyroid cancer and other thyroid diseases as a function of dose in children exposed to radioactivity as a result of the Chernobyl accident.
Principal Investigators: David Becker, MD, Cornell University, NY./Bruce Wachholz, PhD, National Cancer Institute, Bethesda, MD (Project Manager); Nicolai Krisenko, MD, Deputy Minister of Health, Minsk, Belarus.
Sources of Support: U.S.: DOE, NRC, NCI; Government of Belarus
Status: Signed May 26, 1995. The cohort study is in its first year, and a small case control study has been completed.

B. Ukraine: Childhood Thyroid Study

Objectives: To develop risk estimates for thyroid cancer and other thyroid diseases as a function of dose in children exposed to radioactivity as a result of the Chernobyl accident.
Principal Investigators: David V. Becker, MD, Cornell University Medical College, NY/Bruce Wachholz, PhD, National Cancer Institute (Project Manager), Bethesda, MD.; Nikolai D. Tronko, Ukrainian Research Institute of Endocrinology and Metabolism (URIEM), Kiev, Ukraine.
Sources of Support: U.S.: DOE, NRC NCI; Ukraine
Status: In first year

C. Ukraine: Leukemia Study in Chernobyl Cleanup Workers

Objectives: To develop risk estimates for leukemia in Chernobyl liquidators (cleanup workers) exposed to chronic doses of radiation.

Principal Investigators: United States: Gilbert W. Beebe, PhD//Bruce Wachholz, PhD, National Cancer Institute, Bethesda, MD (Project Manager); Anatoley Romanenko, MD, Ukraine Research Center for Radiation Medicine (URCRM), Kiev, Ukraine.
Sources of Support: U.S.: DOE, NCI; Ukraine, France
Status: Expected to begin in early 1997.

D. Ukraine: Eye Cataracts in Chernobyl Cleanup Workers

Objectives: To obtain reliable estimate of risk of cataract development in a dose-defined cleanup worker population (liquidators) involved in the Chernobyl accident and be able to address the question of whether or not induction of cataracts by radiation should continue to be viewed as deterministic.
Principal Investigators: United States: Basil V. Worgul, PhD, Columbia University, NY.; Ilia A. Liktaryov, Ukraine Scientific Center for Radiation Medicine (USCRM), Kiev,Ukraine.
Sources of Support: U.S.: DOE; Ukraine
Status: Project was initiated in third quarter of 1995.

E. Ukraine: Pilot Eye-Cataract and supporting Dosimetry Studies

Objectives: This is a pilot study of dosimetry development and application activities with emphasis on application to the current Ukrainian-American study on "Eye Cataracts in Chernobyl cleanup workers".
Principal Investigators: United States: Lynn Anspaugh; Lawrence Livermore Laboratory, University Of California, Livermore, CA.; Ilia A. Liktaryov, Ukraine Scientific Center for Radiation Medicine (USCRM), Kiev,Ukraine.
Sources of Support: U.S.: DOE.
Status: This is an eight-month pilot project initiated in March 1996.

I would just like to say working at the Department of Energy is good training for talking through buzzers.

[Laughter.]

Chairman ROHRABACHER. I'm going to put this Committee into recess. We're down to about 12 minutes. Then right after the last vote we'll come right back here. There are supposed to be two votes. So please vote quickly and then come back here immediately and we will reconvene at that time.

So this Committee is in recess.

[Recess taken for the Members to vote.]

AFTER RECESS

Chairman ROHRABACHER. This hearing will come to order.

If we could ask the witnesses to return to their seats, we will proceed.

I believe that Mr. Doyle is next, but Mr. Foley is here.

Mr. Bayne will join us when he can.

Mr. Foley, would you like to proceed.

Mr. FOLEY. Thank you very much, Mr. Chairman. I appreciate it.

I would first like to ask Mr. Lash on an item that is important to Florida. What is the Department doing in an effort to stymie or stop the construction of the nuclear facility proposed for Cuba? Are we doing anything to force the international community to not participate in the construction of that proposed nuclear facility?

Dr. LASH. Yes. We are not at all in favor of the announced intentions from Cuba and the indication from Russia that they would support Cuba's intention to complete that nuclear power plant.

Now of course the Department of State has the lead on this issue as an international relations matter, but the Department of Energy has been fully supportive of the State Department's activities in supplying information that we've been able to gather and also basing our opinions upon our familiarity with Soviet-designed reactors in several other countries in which we're actively involved.

So we're not at all in favor of that, and we're supporting the State Department in its efforts to encourage companies in other countries from participating in this. In our meetings with the Minister of Atomic Energy McHiloff we told him explicitly about our opposition to this. I was a participant in meetings that Secretary O'Leary has had with Minister McHiloff on this point. So we're doing everything that we can to support you in that effort.

Mr. FOLEY. I would also like to follow up on another matter. I know that there was discussion on the orders or likely commitments from utilities on the advanced light water reactor. In light of the limited domestic and international markets, and particularly because China has been named as a possible customer, does the Department of Energy support lifting the nuclear export ban to China or any other nation for that matter?

Dr. LASH. Well the lifting of the ban would not be a Department of Energy initiative separate from any Administration position, and I'm unaware of any Administration initiative in that area right now.

Our role is to support the Department of State in its interactions with China, and we are very, very careful to follow not only the letter of the law on this, but also the policy guidance that we receive from the Department of State, and we're not doing anything separately from that.

Mr. FOLEY. Thank you.

I have some more questions for Mr. Bayne, and I hope he arrives during my presentation.

I want to welcome Mr. Schatz and Mr. Freedman.

And certainly I want to go on record today, Mr. Chairman, in hopes of pursuing the elimination of the advanced light water reactor as we did last year with the gas turbine. We want to have that same—we hope—team effort to stopping a program that I think has gone far past its usefulness.

From all indications of what I've read from the material, it was a five-year project and we've reached that stage. Very few are indicating any commercial viability at least on an order basis for the project. So I certainly add my voice today in the Subcommittee and let it be known that I intend to pursue an elimination of the funding for this propose here in Subcommittee, on the floor or wherever it may deem necessary.

[Mr. Bayne returns to the witness table.]

Mr. Bayne, welcome. I wanted to ask you a question. First I had just asked Mr. Lash the question regarding the intent of Cuba to complete its nuclear facility, and they're engaging the international community in hopes of finding an investor, partner or what-have-you, and I would like to know what is the Nuclear Energy Institute doing to try and stymie the efforts of the Cuban government in order to build a reactor which would have I think severe consequences for my State of Florida, but in fact based on the photos I've seen, it would have a Chernobyl-type effect if in fact it was ever allowed to be completed.

Mr. BAYNE. Frankly we have not been involved in that. Your comment about a Chernobyl-type event I think is entirely in error. It is not a Chernobyl-type reactor.

Mr. FOLEY. Well we'll play semantics then. I'm not sure. I'm trying to define it as a Chernobyl reactor. I guess my main concern is, if completed could it have the same devastating effect if incorrectly or improperly manufactured or if they don't adhere to the type of safety requirements that are required in our domestic industry.

I guess based on the fact that you are proponents of nuclear energy and that you are proponents of safe nuclear energy, I would hope that we would use whatever pressure, momentum or contacts we have with the international community to see that a reactor that would possibly be unsafe for Cuba as well as the Caribbean nations would be objected to.

Mr. BAYNE. Yes, sir I agree with your comment about not wanting to build unsafe reactors, but I think you need to clarify the point about the consequences of an accident. An accident in a reactor of our type is not at all like a Chernobyl-type accident because the physics of the problem is such that in a Chernobyl accident where you burn the radioactivity and send it into the atmosphere is different than a water-based reactor where most of the fission products are salts, and salts are soluble in water. So if you have an accident in a water-type reactor, the fission products are dissolved in the water and stay with the reactor inside the containment building or inside the reactor vessel.

The reason Chernobyl was so bad is you burned it all and put it all into the atmosphere, and we don't have a reactor like that, and I don't think the Cuban reactor is like that either. We would not support building unsafe reactors or building reactors that are built not following safe standards.

Chairman ROHRABACHER. Well thank you very much, and thank you, Mr. Foley.

Seeing that we don't have any more Members with us today, I would like to thank our panelists. Thank you very much for your presentations.

This hearing is adjourned.

[The Committee adjourned at 1:40 p.m., subject to the call of the Chair.]

[The following material was received for the record:]

Appendix

Statements for the Record

UNITED STATES

HOUSE OF REPRESENTATIVES

SCIENCE COMMITTEE

ENERGY AND ENVIRONMENT

SUBCOMMITTEE

Statement on the

Advanced Light Water Reactor Program

by

Robert M. Vijuk

Westinghouse Electric Corporation
Energy Systems Business Unit

Monroeville, Pennsylvania

May 6, 1996

Mr. Chairman and Members of the Subcommittee:

As Project Manager for AP600 Design Certification in the Energy Systems Business Unit of the Westinghouse Electric Corporation, it is my privilege to outline for you the status and progress on the ALWR program, and in particular the AP600.

Congress' Energy Policy Act of 1992 defined several imperatives which must be addressed throughout the remainder of this century. Among these imperatives is the need to *keep the nuclear option open for the United States.* In response and in parallel, the nuclear industry has developed a comprehensive strategic plan aggressively devoted to making sure that this country has the nuclear option when needed.

Toward these ends, Westinghouse continues to invest heavily in the development of advanced nuclear plants. The facts support our belief that, even with necessary and aggressive conservation, increased energy efficiency, and advancements in renewable energy resources, new baseload power plants will be needed to support economic growth in the next century. Our nation's economy, growing even at a moderate rate, will dictate the need for additional generation capacity. As the need for new baseload generating capacity arrives during the next 15 years, we must have all available options at the ready so that effective choices can be made.

Keeping in the forefront of nuclear technology is also vital from an international perspective. The United States has long been the world leader in the commercialization of nuclear technology and the world continues to look to us for technology development. Indeed, without a strong nuclear program, our influence in shaping the international nuclear noun proliferation regime would be greatly diminished.

We firmly believe that we must continue to set the worldwide standard to provide the safest and best-engineered nuclear designs, components, and fuel services worldwide. The nuclear export market is also significant with up to 50 nuclear power plants expected to be built in Southeast Asia over the next 15 years. The modular engineering and fabrication concepts in the AP600 result in a high U.S. content and one plant order alone would provide up to 5,000 jobs for five years.

The AP600 design has generated such strong interest worldwide that 20 nations (including France, Italy, Spain and Japan) have joined the engineering and testing efforts. This international coalition is strong evidence that the world still looks to the United States for leadership in nuclear power and that AP600 meets the test of a world-class product. Congress' recognition of potential worldwide environmental problems, if the energy needs of Southeast Asia are met solely with fossil fuel plants, places additional emphasis on the importance of AP600.

AP600 is a simplified, safe, and economical 600-megawatt power plant, poised to provide a new era of nuclear power generation. Designed to satisfy the standards set by the U.S. Department of Energy and embodying the principles of the Advanced Light Water Reactor

Utility Requirements Document, AP600 is an elegant combination of innovative safety systems that rely on dependable natural forces and proven technologies.

As is well known worldwide, the Westinghouse AP600 approach has been to provide certainty -- to the utilities, to the financial community, and to the public -- with a design that:

- Simplifies plant systems and equipment, operation, inspections and maintenance by greatly reducing the amount of valves, pumps, piping, HVAC ducting, and other complex components.
- Uses experienced-based power generation components which are designed to offer a high level of reliability.
- Provides a high degree of public safety and licensing certainty.
- Shortens construction schedules and increases schedule certainty by the use of modular components, giving AP600 the ability to be constructed in three years from pouring the first concrete to fuel loading.
- Uses standardization to offer electric power at a competitive cost.

From 1985 to 1989, Westinghouse completed preliminary design and proof of principle testing for AP600, including cost and schedule estimates, under a program funded by DOE and EPRI. In 1990, Westinghouse was awarded the design certification contract from DOE and EPRI and the scope was jointly determined for the cost-shared $120M Design Certification Program ($50M from DOE, $22M from EPRI, and $48M from Westinghouse). In March 1993, the companion cost-shared program on First-of-a-Kind Engineering (FOAKE) was awarded to Westinghouse as a result of a market-driven utility selection process. This program, together with the Design Certification Program, will provide the certainty in safety, licensing, cost, and schedule which is needed for public, investor, and utility confidence to proceed with nuclear power. The FOAKE program scope totals $158M ($86M DOE/Advanced Reactors Corporation and $72M Westinghouse).

Westinghouse has already expended $125M on these two essential programs and is providing a major share of the industry cost sharing. In addition, Westinghouse will repay $25M of the DOE funding on design certification as royalties from the sale of the first AP600 plant. Westinghouse has proceeded aggressively with the program and has successfully completed the $13 million test program at Oregon State University and all other design certification testing programs. The results of these test programs have been used successfully to verify the computer programs to evaluate the performance of the AP600. The NRC are now using the world-class Oregon test facility for their own research programs.

In FY 1996, Congress approved $40 million for the entire Advanced Light Water Reactor (ALWR) program and DOE allocated $11 million as their share of AP600 design certification costs. This was a $3 million reduction from the amount needed to keep the program on schedule. There was also a substantial increase in the fees from the NRC for its work on approving the design even beyond the amounts on which the FY 1995 and FY 1996 appropriations were based. It should be noted that as a result of OBRA in 1992, NRC fees were required to be paid by the project. This occurred after the program had started and represented additional costs.

The design certification program is now 88 percent complete, and is targeted for final design approval from the NRC by the end of the first quarter in 1997, provided funding levels are maintained. For FY 1997 out of the total amount appropriated for the ALWR program, $10 million is needed for AP600 design certification..

The ability to market AP600 successfully around the world, particularly in the Asian nations that will place orders for nuclear power plants in the next three years, depends on the timely receipt of final design approval from the NRC. Further delays beyond those that have already resulted from funding shortfalls in FY 1996 will give foreign competitors a crucial advantage and potentially deprive the United States of these very important American labor-intensive orders.

Under the 1992 FOAKE, agreement between DOE and the Advanced Reactors Corporation, ARC was to fund and manage FOAKE on two of the advanced reactor designs currently in the design certification process. After a rigorous bid and proposal and market selection process, ARC selected the AP600 as the mid-size plant to receive FOAKE funding. There are several noteworthy and innovative characteristics of this model government-industry program:

- The total FOAKE program for both reactors is $270 million, the majority (63 percent) of which comes from the private sector--utilities and reactor designers.

- *As directed by Title XXI of the Energy Policy Act of 1992, DOE committed $100 million (37 percent). Under the DOE/ARC cooperative agreement, DOE's contribution will be repaid from revenues received from the sale or licensing of plants or technology developed in this program.*

The AP600 FOAKE program is 52 percent complete, and is on schedule for completion in Fiscal Year 1998, as required under the DOE/ARC agreement. Funding required for FOAKE in FY 1997 is $17 million.

FOAKE is vital to the utility industry's efforts to assure that the nuclear option is preserved, and the DOE/ARC contractual agreement is indicative of the joint commitment. Congress and the Administration have made legislative and contractual commitment to the program, which has two years to completion. . The United States will be repaid for its investment in a successful program while also meeting the economic and energy goals of the Congress, and the Administration.

In summary, for FY 1997, out of the total amount appropriated for the ALWR program, $27 million is requested for the AP600 core program. This core program includes $10 million for AP600 design certification. The FOAKE funding needed is $17 million, which is consistent with the 1993 agreement between DOE, ARC and Westinghouse to assure FOAKE completion on time in FY 1989.

Finally, substantial progress has been made in the AP600 program, and the ALWR program overall, the full support and cooperation of the utility members of the Advanced Reactors Corporation, the DOE, and the domestic and international members of the AP600 team.

We believe this progress and this program are:

- Vital to the future of nuclear power in America,
- Vital to developing technology exports and jobs for America,
- Necessary to maintain and enhance our influence in international nuclear policy.

Thank you.

Written Statement

Submitted to the

Subcommittee on Energy & Environment

of the

U.S. House of Representatives

Committee on Science

Concerning the Subject of Advanced Light Water Reactors

By

George A. Davis
Project Manager, System 80+ Deployment, U.S.
ABB Combustion Engineering Nuclear Systems
Windsor, Connecticut

May 6, 1996

Introduction

ABB Combustion Engineering is pleased to have this opportunity to provide a written statement to the Committee, as the Committee considers the Department of Energy's FY-97 budget request. Specifically, we would like to address the area of DOE's budget request that relates to Advanced Light Water Reactors (under the Nuclear Energy Program).

We would like to point out that our System 80+ standard design has completed review and approval by the Nuclear Regulatory Commission and is currently finishing up the rulemaking process that will result in issuance of one of the first two Design Certifications, under the new one-step licensing process in 10CFR52. These two certifications will mark the completion of a decade-long effort by industry and DOE, in what has proven to be the centerpiece of the ALWR program. We only ask that the Committee provide adequate funding to assure that DOE can fulfill its contractual obligation ($3 million) for completing this extremely important effort in FY-97.

Advanced Light Water Reactor Program

For the last decade, DOE and the nuclear industry have cost shared in the development and licensing of the ALWR designs. The first major projects to be completed under this program will be the NRC Design Certification of the large, evolutionary designs: ABB Combustion Engineering's System 80+ standard design and General Electric's ABWR design. The Design Certifications, to be issued via rulemakings later in calendar year 1996, will mark a major milestone in maintaining the viability of the U.S. nuclear energy option. Since the designs are already being actively marketed in Asia, the federal government may soon share in the benefits of creating high technology export products -- products that will add thousands of highly skilled jobs to the U.S. economy, as well as improvement to the balance of trade picture.

ABB-CE and GE have contributed more than $100 million of cost-share to the certification of these designs. To support the NRC review, we have often risked our own funds to fulfill commitments to NRC -- even though DOE did not have adequate funding to support its cost share commitments at the time. We took such initiatives in good faith -- because we recognized that maintaining the NRC's review on schedule would minimize the program's costs and we knew that DOE would try to be fair with us in future budget allocations. As we approach the completion of this program, it is essential that the Committee provide DOE with sufficient funds to fulfill its final obligations to our project. We estimate that the FY-97 funding needed to complete System 80+ Design Certification will be $3 million. We understand that DOE agrees with this figure.

Completion of our Design Certification program in early FY-97 will mark a major success for DOE's ALWR program. It will also mark the end of DOE funding for our System 80+ certification effort.

At the May 1 hearing of the Committee, there was much discussion about the lack of a U.S. market for ALWRs for the foreseeable future. For the record, we would like to be sure that the Committee is aware of our efforts to deploy our System 80+ design here in the U.S. by convincing DOE to consider its use for two important missions: tritium production and plutonium disposition. We proposed that private industry could finance the construction of a

System 80+ nuclear facility on DOE's Savannah River Site, that would sell electricity and sell services to the government (tritium production and plutonium disposition). By locating the facility on a government site and by selling services to the government, in addition to electricity sales, the private venture would be economically viable. In fact, it is the most viable approach for deploying new ALWRs in the U.S. in the near future. Unfortunately, DOE has been unwilling to seriously consider our privatization proposal -- which is described below.

Tritium Production and Plutonium Disposition

ABB Combustion Engineering, has teamed with seven other companies and proposed a plan to the Department of Energy for the deployment of a privatized multipurpose reactor facility on DOE's Savannah River Site. Our team includes several other large engineering companies -- in particular, Stone & Webster Engineering Corporation, Duke Engineering & Services, Raytheon Engineers & Constructors, and BNFL, Inc. We originally developed an interest in this concept in late 1992, when Congress requested that DOE consider the possibility of a multipurpose reactor that could (1) produce tritium, (2) consume excess weapons plutonium as fuel, and (3) generate electricity, as a way to offset the government's costs. We felt that our System 80+ ALWR design (the same one that has been undergoing NRC review for the past decade, as part of DOE's ALWR program) was ideally suited for such a mission -- especially since our design already included features needed for consumption of plutonium fuel. Since we were nearing the end of the review process at the NRC and were about to begin bidding the design as a fixed price turnkey offer overseas, we felt that we would be in a unique position to allow the project to proceed quickly and, very importantly, to be privatized. Not surprisingly, the National Academy of Sciences' reports on plutonium disposition identify our System 80+ design as the most efficient and least-cost reactor model available for disposition of excess weapons plutonium, if a new reactor were to be used.

In March 1994 we submitted to DOE a Program Plan for organizing a consortium that would privately finance, build, own, and operate the multipurpose reactor facility on DOE's Savannah River Site. The facility would consist of two System 80+ standardized units, along with a fuel manufacturing building. The consortium would be formed as an Independent Power Producer that would contract to sell electricity to utilities throughout the Southeastern U.S. and contract with DOE to provide two services: irradiation of tritium-producing targets and disposition of excess weapons plutonium, by consuming it as fuel. Thus, DOE would only have to purchase the services that it needs, rather than purchase and operate the entire facility. Besides minimizing the government's costs, this has the distinct advantage that it allows the government to avoid billions of dollars in outlays to build new facilities for production of tritium and disposition of plutonium over the next ten years. Instead, the engineering, licensing, and construction would be done with private financing. DOE would then begin paying fees for services rendered, after the facility goes operational.

Based on our initial cost estimates to build and operate the multipurpose reactor facility and our market analysis of future electricity prices in the southeastern U.S., we estimate that the electricity sales would cover about 90% of the costs. The remainder would be charged to DOE for the services that it receives. Since the plutonium disposition mission can be well defined up-front, before DOE has to make contractual commitments, we proposed that DOE pay a fixed annual fee for disposition of excess weapons plutonium -- currently estimated at $78 million per year in constant 1995 dollars.

Since the long term needs for tritium production are not as easily defined, and may be subject to change, we proposed that DOE pay a variable annual fee for irradiating targets. The fee would cover lost electricity sales, if any, when tritium is being produced. To produce tritium at the rate of 3/8 of the 1988 goal (DOE's current upper limit estimate), we estimate the variable fee could be as high as $53 million per year. However, if no tritium were being produced, then no fee would be have to be paid. This gives DOE the maximum flexibility in contracting for the service. Compared to the alternative of DOE building a new dedicated facility for tritium (e.g., the accelerator), our approach avoids the risk that billions of dollars might be spent to build a facility and then later find that it is no longer needed, or is incorrectly sized.

Our Plan proposes that the initial effort to organize the project and establish power sales agreements be paid by DOE. At the end of that period, there would be a financial closing and the privatized project would then proceed, without the need for DOE funding until the facility goes operational and services are being provided. We would pay back the initial DOE funding, if DOE agrees to go forward with implementation of the project. The requirement that DOE pay the initial funding before the project goes forward recognizes the reality that many major DOE initiatives are subject to changing political and world events, which are outside the control of the our team.

In September 1995, we submitted an Alternate Plan to DOE -- to address the Department's concerns about the difficulty in establishing long term power sales agreements with utilities. The Alternate Plan focuses upon the use of a single System 80+ reactor, which dramatically reduces the amount of private capital that must be raised and the amount of electricity that must be sold. The Alternate Plan also uses a greatly simplified method of selling electricity from the plant, by using a power marketer and selling at the market prices for electricity, when it is generated. This will increase uncertainty in electricity revenues, which would then have to be borne by the consortium and the federal government; however, it will assure that the effort to launch the private venture will succeed. Although we still believe that our original March 1994 Program Plan is achievable and in the government's best interest, we feel that the Alternate Plan represents a fall-back scenario that assures a successful outcome.

In its Record of Decision on Tritium Production in December 1995, DOE announced that it would pursue a parallel track for the next three years to (1) continue research & development of an accelerator, and (2) evaluate the use of one or more of the existing 110 commercial nuclear plants that are currently operating in the United States. DOE's decision acknowledged that the existing reactor option would have the least cost, least risk, shortest schedule, and minimum environmental impact. However, because of concerns about adopting a policy that allows production of nuclear weapons material in commercial nuclear plants that were originally constructed for purely peaceful purposes, DOE felt justified in pursuing the accelerator research, in parallel. Press reports and internal DOE documents indicate that DOE plans to devote 85 to 90% of its tritium budget, over the next several years, for the accelerator research.

In its decision, DOE dropped any further consideration of a new ALWR for this mission, even though its own consultant's estimate shows that a new large ALWR (using our System 80+ design as a reference) would likely cost the federal government about $12 billion less to build and operate than the accelerator, in undiscounted 1995 dollars. For reference, the consultant estimated that the accelerator will cost between $12 billion and $27 billion to design, construct. and operate (also in undiscounted 1995 dollars) -- at the 3/8 goal tritium production rate.

On top of this, we have notified DOE that we believe that there are a number of errors in the consultant's analyses and that the cost difference between the ALWR and the accelerator is even greater than the consultant calculated. Although DOE has provided responses, they have not adequately addressed our concerns and we believe that our original comments remain valid.

DOE also dropped any consideration of our proposed new privatized multipurpose reactor, even though its Record of Decision noted that one of its own laboratories, Oak Ridge, had provided a cost estimate which showed that our concept would cost the federal government billions of dollars less than DOE's estimate for the accelerator, while also fulfilling another DOE need -- the disposition of excess weapons plutonium. (As a side note, the Oak Ridge analysis was performed in response to a request from the Energy & Water Appropriations Conference Committee -- which had asked DOE to evaluate the feasibility of a multipurpose ALWR, during the FY-95 budget process. The report was due to the Committee a year ago this month. Although the draft report was completed on schedule, DOE has still not released it to Congress.)

In spite of the dramatically higher cost for the accelerator, DOE justified the accelerator's selection over a new ALWR on the basis that the accelerator has less environmental impact and less licensing risk. However, both of these arguments are fallacious. DOE's assertion that the accelerator has less environmental impact than a new ALWR is fatally flawed because DOE failed to include the environmental impact of generating the 300 to 600 Megawatts of electricity that the accelerator will require during operation. Its inclusion would show that the new ALWR has less environmental impact than the accelerator -- especially when it is also acknowledged that the new ALWR will avoid the need for an equivalent amount of fossil fueled electric generating capacity in the region, thus, creating an environmental benefit. We strongly suspect that DOE's segmentation of the accelerator's environmental impact is not consistent with the National Environmental Policy Act and could make the accelerator vulnerable to court challenge, at some time in the future, by those who do not want tritium production to be restarted.

On the subject of licensing risks, it appears that DOE has not given due credit to the "one step licensing" provisions provided in the 1992 Energy Policy Act. It is now possible to obtain the permits to both build and operate a new ALWR nuclear plant before construction is even started. Furthermore, we are talking about using a standardized ALWR plant design that has already been reviewed and certified by the NRC. DOE has invested about half a billion dollars in the ALWR program during the last decade, in cost-share with the nuclear industry, with the primary goal to receive NRC Certification of these safer, new reactor designs. In an ironic and bizarre twist of fate, DOE is now saying that these designs are not acceptable for use by DOE -- even though their own cost analyses show the ALWR to be less expensive than the accelerator that they selected. Concerning licensing of the accelerator, it should be noted that DOE recently announced plans for seeking outside regulation of all its facilities. There are no current licensing guidelines or processes for licensing an accelerator like the one proposed for tritium production. This is true licensing uncertainty. In the end, DOE will run the same risks of intervenor challenges, during licensing of a new tritium production facility, from those groups opposed to resumption of tritium production -- no matter which technology is used.

To summarize this issue, we believe that DOE's decision to drop the large ALWRs from further consideration for tritium production is not supported by the facts. DOE now proposes to commit over 85% of its tritium budget to research on an unproven accelerator design that, by estimates from DOE's own consultant, will likely cost the federal government on the order of $12 billion more than the large ALWR (we think that the cost gap is even larger). Furthermore, if DOE would include our proposed concept for a new privatized multipurpose reactor, DOE would then have a more cost-effective, reliable alternative to the existing reactor option. DOE would still have the flexibility of purchasing irradiation services -- be it from an existing reactor or a new one, on a government site.

Additional Material for the Record

Improving the Environment

An Evaluation of DOE's Environmental Management Program

Committee to Evaluate the Science, Engineering, and
Health Basis of the Department of Energy's
Environmental Management Program

National Research Council

National Academy Press
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Committee to Evaluate the Science, Engineering, and Health Basis of the Department of Energy's Environmental Management Program

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Preface

In a letter that I received on January 11, 1995, Thomas Grumbly, U.S. Department of Energy (DOE) Assistant Secretary for Environmental Management, requested the assistance of the Academy in addressing remedial-action and waste-management problems that his office and the nation are now facing as a result of 50 years of nuclear weapons development and testing (see Appendix A). These are problems that require a re-engineering of systems and a re-examination of the scientific, engineering, and institutional barriers to achieving cost-effective and safe stewardship of the nation's resources.

In response to this request, the National Research Council established the Committee to Evaluate the Science, Engineering, and Health Basis of the Department of Energy's Environmental Management Program. Four subcommittees were formed to address topics outlined in Mr. Grumbly's request. The subcommittees were assigned the following topics:

- Evaluation of regulatory measures.
- Setting priorities, timing, and staging.
- Utilization of science, engineering, and technology.
- Integration of science, engineering, and health in program implementation.

Subcommittee membership (see Appendix C) included a unique combination of those from the scientific and technological community and participants knowledgeable about the concerns of the various stakeholder groups that are involved in DOE's environmental remediation process. The knowledge of these stakeholders included substantive expertise and site-specific experience with the process involved in DOE's environmental remediation program. These individuals, having experience in state and federal agencies involved in monitoring DOE's cleanup operations, national and local citizen, environmental, and American Indian groups, and DOE's citizen taskforces, were able to provide a unique contribution as members of each subcommittee. Members of the subcommittees also included individuals who have addressed similar problems in industry and individuals with background in federal and state government management, including members of the National Academy of Public Administration.

In terms of process, each subcommittee held a workshop which offered an opportunity for public input, followed immediately by a meeting of the subcommittee to develop a brief report. Prior background readings, knowledge, and discussions resulting from the workshops provided the basis for the subcommittees' deliberations. The four subcommittee reports were submitted to a synthesis committee which included the chairs of each of the subcommittees and selected members to provide a spectrum of viewpoints. The subcommittees' complete reports, as well as that of the synthesis committee, follow. Though the memberships of the subcommittees were selected to provide different viewpoints and experience and each of the subcommittees deliberated separately, there was surprising consensus among the reports of the four subcommittees. Beyond the synthesis committee report, no attempt was made to conform the results of the four separate subcommittee deliberations. The reader should look to the individual reports for further detail and for additional recommendations and observations.

Although these reports represent the work of each of the committees, they benefited greatly from the support of the National Research Council staff, specifically, Paul Gilman, who helped refine all the reports, and Deborah Stine, who coordinated the various project activities for the overall report. Each subcommittee was also helped by its staff, Ray Wassel for Regulatory Measures, Tamae Wong for Integration, Stephen Parker and Karyanil Thomas for Utilization, and Robert Andrews for Priority-Setting. In addition, Patrick Sevcik, Helen Chin, Ruth Danoff, and Patricia Jones provided invaluable support.

The National Research Council also acknowledges with appreciation presentations made at the workshops by the persons listed in Appendix D.

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Part I
Synthesis Report

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Introduction

In a letter to the President of the National Academy of Sciences, Thomas Grumbly, U.S. Department of Energy Assistant Secretary of Environmental Management, requested the assistance of the Academy in addressing remedial action and waste management problems that his office and the nation are now facing as a result of 50 years of nuclear weapons development and testing (see Appendix A). These problems require a re-engineering of systems and a re-examination of the scientific, engineering, and institutional barriers to achieving cost-effective and safe stewardship of the Department's resources. In response to the request, the National Research Council of the Academy established the Committee to Evaluate the Science, Engineering, and Health Basis of the Department of Energy's Environmental Management Program. Four subcommittees were formed to address topics outlined in Mr. Grumbly's request. The subcommittees were assigned the following topics:

- Evaluation of regulatory measures.
- Setting priorities, timing, and staging.
- Utilization of science, engineering, and technology.
- Integration of science, engineering, and health in the implementation of the Environmental Management Program.

Each subcommittee held a workshop that was followed immediately by a meeting to develop a brief report. Information and discussions resulting from the workshops as well as background documents reviewed in preparation for the workshops informed the subcommittees' deliberations. The subcommittees' four reports were submitted to the synthesis subcommittee that was formed to draw key points from each of them. This is the report of the synthesis subcommittee; the subcommittees' complete reports follow. Though the memberships of the subcommittees were selected to provide different viewpoints and experience there was surprising consensus among the subcommittees, though no attempt was made to conform the results of their separate deliberations. The reader should look to the different reports for further detail on the issues raised here and for additional recommendations and observations.

PROBLEMS ASSOCIATED WITH THE DEPARTMENT'S LEGACY

The United States involvement in nuclear weapons development for the last 50 years has resulted in the development of a vast research, production, and testing network known as the nuclear weapons complex; over $300 billion (in 1995 dollars) has been invested in the activities of this complex. The Department has begun the environmental remediation of the complex, which will encompass radiological and nonradiological hazards, vast volumes of contaminated water and soil, and over 7,000 contaminated structures (DOE, 1995a). The Department must characterize, treat, and dispose of hazardous and radioactive wastes that have been accumulating for more than 50 years at 120 sites in 36 states and territories. By 1995, the Department had spent about $23 billion in identifying and characterizing its waste, managing it, and assessing the remediation necessary for its sites and facilities. The Department estimates that the remedial action at Department sites (not including groundwater cleanup, currently operating facilities and Naval facilities) could cost a total of $200–350 billion and take at least 75 years to complete (DOE, 1995b). According to the estimates of the total cost, 49% would go to waste management, 28% to environmental restoration, 10% to nuclear material and facility stabilization, and 5% to technology development with the remaining 8% for activities such as site security, transportation, and other landlord activities.

Environmental Management is also responsible for conducting the program for waste minimization and pollution prevention for the Department. The variety and volume of the Department's current activities make this effort a challenge itself. The Department has nearly 30 contractor operated laboratories employing about 50,000 people who are engaged in the full spectrum of scientific and engineering disciplines. Moreover, the Department is engaged in the largest weapons-dismantlement effort in its history. Current programmatic activities in nuclear weapons, energy, and basic research, as well as current remediation efforts are the subject of an initiative announced by Secretary O'Leary to reduce by 50% the amount of toxic waste that the Department's facilities produce by the year 1999 (DOE, 1995c).

The Department's Office of Environmental Management was established in 1989 to deal with the environmental legacy of the Department's nuclear weapons program. The Environmental Management Program has six goals which have been established by Assistant Secretary Grumbly:

- To eliminate and manage urgent risks in the system.
- To emphasize the health and safety of workers and the public.
- To establish a system that includes sound managerial and financial controls.
- To demonstrate tangible results.
- To focus technology development on identifying and overcoming obstacles to progress.
- To establish a stronger partnership between the Department and its stakeholders.

The Department's historical culture of secrecy and its contamination problems at nuclear weapons sites have combined to affect public attitudes and public opinion in a profound way. Citizens have expressed concern at the community and national levels about the potential health and environmental impacts of conditions in the nuclear weapons complex, urging that sites be cleaned up. Technology to characterize and remediate contaminated soil or water or to treat, store, and dispose of accumulated waste safely does not always exist. For most sites, waste-disposal standards and goals for cleanup levels for the environment have not been developed, agreed to, or applied (OTA, 1991).

FUNDAMENTAL PRECEPTS FOR THE DEPARTMENT'S ENVIRONMENTAL MANAGEMENT PROGRAM

Several fundamental precepts about the Department's Environmental Management Program should be understood before one attempts to analyze the program in an informed manner.

Risk Associated with the Program

The contamination at the weapons complex is serious and extensive. The biggest risks are those to workers, and these risks arise from addressing contamination and waste problems and from managing the contamination or waste in place (OTA, 1991; Blush and Heitman, 1995; CERE, 1995). Examples of these significant worker risks include plutonium that is packaged in unstable forms, rooms that are heavily contaminated with plutonium and other radionuclides, and spent fuel that is corroding in cooling ponds.

Public health is at less immediate risk than is worker safety, largely because most waste and contamination is being managed and contained at present. There is still cause for real concern in this area, though, particularly over the medium to long-term. The current mechanisms for managing and containing potential public health risks (such as controlling access to the site) will degrade long before the contamination becomes benign. Some contaminants have moved offsite (such as plutonium-contaminated soil at Rocky Flats) or are in the process of moving offsite (such as contaminated groundwater at Hanford moving toward the Columbia River). Because of a lack of agreed-upon cleanup standards, commitments made before problems were understood, and limited risk studies, in many cases it is not possible to separate truly hazardous conditions from those where contamination is measurable, but not a serious health risk. Nevertheless, this uncertainty must not be used as a rationale for not moving ahead aggressively with cleanup programs.

Cost of the Program

The magnitude of the cleanup job facing the Department is usually communicated by simply repeating the annual budget for the activity, $6.5 billion. The shocking fact about that amount is that fully $4 billion of it is spent simply to maintain facilities and sites in an attempt to contain contamination and to maintain old facilities for which funds for decommissioning are unavailable. The Department is running in place and spending $4 billion a year to do it, and this figure will grow if nothing is done to increase site remediation and facility decontamination and decommissioning.

Length of the Program

The expectation that the remediation process will continue for at least 75 years (DOE, 1995b) affects the approach to planning, managing, and technology selection and development. Stabilization of a site now and development of a better technology, instead of detailed characterization of the site, might be the better approach to an already-costly problem. Planning and technology development must be iterative because conditions will change and new developments that will need to be factored into the Department's decision-making will take place. Priorities will change as political leadership changes. All this will make the management of the Program a continuing challenge.

The long duration of remediation should not be interpreted as a mandate for inaction, but for management and technical approaches that will change over time.

Science and Technology in the Program

Many waste-management problems in the Department lend themselves to solutions that have already found application in the private sector. Many do not. In some circumstances, technologies and processes for safe and efficient remediation or waste minimization do not exist. In other cases, the development of new technology and processes might substantially reduce the costs of, or risks associated with, remediation and waste management. An effective technology-development program focused on such opportunities is an essential element of an overall strategy for reducing the cost and speeding the pace of the Environmental Management Program.

In some cases, fundamental science questions will have to be addressed before a technology or process can be engineered. For example, improved understanding of the principles of pollutant transport in groundwater is required for important advancement in the development of groundwater-remediation technology. There is a need to involve more basic science researchers in the challenges of the Department's remediation effort. The formula is simple: Department research managers must fund long-term research programs with the most creative and innovative researchers, and the researchers must be kept involved with the ''customers''—those who have the particular remediation or waste-minimization problems.

Environmental Mission or Environmental Ethic?

The Department spends more resources on its Environmental Management Program than on any other activity, and environmental management is often described as one of the Department's central missions. However, the Department should view its remedial activities as industry does, not as a central mission, but rather as a job that must be completed so that the Department can return to its more basic missions. Viewing it this way will help keep the focus of remediation activities on efficiency and cost effectiveness rather than on creating a self-perpetuating activity.

Waste minimization and pollution prevention should be embraced as integral to the performance of such missions as supporting long-term national security and science and technology development. US industry is refocusing and substantially broadening its vision of how to do its business in this manner, and the Department should do likewise (see also pp. 107–108, 154). For current products and processes, that means setting pollution-prevention goals and acknowledging that the most effective way to reach them is to make environmental criteria a part of experiment, process, and product designs.

ENVIRONMENTAL MANAGEMENT'S NOTABLE INITIATIVES

A number of initiatives are rapidly introducing change into a system that was established during the Cold War. It is too early to assess their effectiveness and how long they will last, but their principles and general direction are encouraging. In our recommendations, we note some of the improvements, and we recognize that change will continue even during the final preparation of this report.

Research and Development Initiative

The Office of Energy Research and the Office of Environmental Management have made a commitment to create a new program designed to integrate a long-term research effort into the Environmental Management Program to make crucial advances. The Congress has allocated $50 million of the Environmental Management Program funding for this effort. Such collaboration is the kind of integration recommended in all the subcommittees' reports. Keys to the success of the effort include consistency of funding, a commitment from program managers in the Department to make it a truly new effort rather than a repackaging of existing programs, and a broad outreach to universities and industries and foreign researchers in partnership with the Department's National Laboratories (see also pp. 117–119, 121–122, 150–151). An example of this kind of an effort is the creation of the Consortium on Risk Evaluation with Stakeholder Participation (CRESP), which resulted from recommendations of an earlier National Research Council report (NRC, 1994).

Contractor Relations

Establishing a system that is managerially and financially in control is one of Environmental Management's stated goals. One example of how it is attempting to achieve that goal is the introduction of a contract-reform initiative. Several basic elements of the reform are increased competition; renewed focus on the protection of workers, the public, and the environment; a results-oriented focus; and performance-based incentives. In recent months, a performance-based integrated contract adopting the elements of the contract-reform initiative has been introduced and implemented at the Rocky Flats Environmental Technology Site. Some workshop participants emphasized that it is too early to predict the effectiveness of the new contract, but all subcommittees strongly supported the intentions and direction of the contract-reform effort (see also pp. 34–35, 79, 147–149). Key to the success of this effort will be a clear written statement by Department leadership of the desired relationship between Department employees and contractors.

Budgeting Process

One notable initiative has been the integration of risk and long-term cost data into budgeting. While we did not undertake a critical review of the technical elements of the report, the publication of *Risks and the Risk Debate:*

Searching for Common Ground, "The First Step" (DOE, 1995d) the broad intent of this effort is indeed an important first step for integrating risk assessment into budgeting. Current efforts to integrate options to reduce the cost of maintaining sites and facilities in a safe status while awaiting remediation, which will necessarily incorporate cost-benefit analysis, will further strengthen the analytical basis of Environmental Management's budgeting process. Environmental Management has correctly recognized that without stakeholder acceptance and consensus on both the process and the outcomes, improved analytical techniques and better factual information will be of less value (although such techniques and information can serve to inform the stakeholders in those decisions).

Public Participation

The Department has made a substantial effort to improve the participation of its many stakeholders in its deliberations and decision-making, and the Secretary has shown exemplary leadership in this regard (see also pp. 69–70, 155). The result is a perceptible improvement in the credibility of the Department and of Environmental Management (surveys of stakeholders taken in 1992 and 1994 and presented to the Secretary of Energy's Advisory Board on October 26, 1995, showed a statistically significant change in the level of trust in the Department's Office of Environmental Management, $p = 0.0003$).

Principal Recommendations

RESULTS NEEDED NOW

There are a number of common themes and observations throughout the four subcommittee reports. One is the observation that the Department has undertaken a long-term task. Nonetheless, there is a consensus among regulators, the Department, Congress, and the public that it is time to get on with the task of cleaning up the nuclear weapons complex. While there may be a consensus to get on with the task there is no real consensus as to what that means. For some it is meeting milestones in compliance agreements and for others it means remediating contaminated soil, groundwater, and buildings, even when the process chosen may take decades and many billions of dollars to complete regardless of what compliance agreement milestones may require. This committee believes getting on with the task, whichever definition one uses, will be accomplished most effectively by implementing a process for decision-making and accountability that includes

- Having a more specific set of goals for the program (see also pp. 66–67, 108–112, 141–142).
- A process for prioritizing tasks which includes among its tools risk assessment, (which should consider the perspectives and values of stakeholders as recommended in *Building Consensus* (NRC, 1994)) and cost-benefit analysis (see also pp. 44–45, 46, 82–83, 103–104, 110, 120–121, 144–145).
- A peer-reviewed remediation and waste-minimization technology selection and development process that is responsive to the needs of those implementing the remediation (see also pp. 65, 104, 113, 116, 119, 121, 122).

- An overall organizational and management structure which both provides an opportunity for stakeholder input in each of the above activities (see also pp. 69–70, 83, 113, 146–147, 155–157) and provides incentives for stakeholders and federal and contract workers to implement these activities of the Environmental Management Program successfully (see also pp. 113, 147–149).

Responsible Stewardship

The lack of appropriate technology or a permanent solution for remediating a polluted site or facility should not be an excuse not to take appropriate steps on a near-term or interim basis. Responsible stewardship means undertaking appropriate near-term or mid-term action to remediate a site to protect the public and the environment when a permanent solution is not at hand. Communities and states that are willing to make institutional commitments to implement such plans for near-term and mid-term remedies are participating in responsible stewardship. In the absence of permanent solutions, responsible stewardship allows progress to be made by providing adequate protection against environmental and human health risks that are serious and long-lived (see also pp. 40–41, 48). It deals with waste in relatively short increments of time, say, 20 years. After such a period, existing approaches should be re-examined, and society can decide what to do for the next 20 years. Until permanent solutions are developed, actions taken as part of responsible stewardship that are irreversible should be avoided.

An example at Hanford related to decisions about contamination along the Columbia River illustrates the idea of responsible stewardship. Stakeholders have placed a high priority on unrestricted access to lands along the river. They have also acknowledged that no solution for complete remediation of the underlying groundwater exists. Therefore, work has focused on the remediation of soils and on remediating and containing sources of groundwater contamination while the long-term goal of unrestricted use of the groundwater is retained.

Another example is the approach taken to management of transuranic waste at the Idaho National Engineering Laboratory. Recently, the Department has undertaken a major effort at consolidating, repackaging, monitoring, and sheltering its transuranic waste. Instead of being exposed to the effects of weather and the possibility of corrosion and leaks, drums containing transuranic waste are stored on concrete or asphalt pads in weather-resistant structures. Much of the waste had been stored in earth-covered drums, which were expected to be needed for only a few years, until a permanent disposal site became available. The Department is now repacking drums that began to corrode or leak and is building new interim storage facilities (DOE, 1995a).

It is important to underscore that responsible stewardship should not be relied on to provide permanent solutions. Some components in radioactive waste can continue to be a threat to human health and safety for thousands of years. The National Research Council (NRC, 1995) concludes for high-level nuclear waste disposal that although it might be reasonable to assume that interim actions can be relied on for some initial period, there is no scientific basis for assuming the long-term effectiveness of institutional controls to protect against releases of the stored radioactive materials.

Land-Use Planning

Many contaminated sites and facilities could be restored to a pristine condition suitable for any desired use; or they could be restored to a point where some uses (e.g., industrial development or recreation) would pose no health risks. In other cases, when permanent remedies are unavailable, surrounding communities could be protected for the near future by interim remedial actions and fencing off sites and facilities. Each of those options is associated with different costs and benefits. Land-use decisions are relevant to the determination of regulatory measures in that different cleanup-level goals might be set for different land-use options with little or no difference in the risks posed to human health (see also pp. 42–43, 111, 112).

The Department believes that most current efforts at land-use planning are inadequate, as are the mechanisms for their implementation. In cases bound by legal obligations or commitments by the Department, some obligations and commitments may not be technically feasible. In cases not bound by legal obligations or commitments by the Department, future land use is unclear. The Department has begun working with stakeholders and regulators regarding the ultimate disposition of lands currently managed by the Department (DOE, 1995b).

We believe that effects on land use and groundwater should be among the first considerations in the planning of remediation. There is also a need for a formal decision-making framework for future land-use and cleanup standards that will provide an opportunity for consensus-based selection of appropriate data, analysis, and criteria for decision-making. The framework must include an opportunity for stakeholder input at all stages and lead to enforceable agreements that can be modified as further knowledge is gained.

If land use restrictions are to be incorporated in cleanup remedies for Department sites there must be clear assurance that the land use will in fact be controlled for the duration of the contamination. This is a serious problem for sites contaminated with long-lived radionuclides. The record of decision selecting the remedy should incorporate specific commitments by the Department designed to maintain the necessary institutional controls over the lifetime of the contamination. Where contaminants are so long-lived that such commitments are impossible, the remedy should include specific procedures designed to reassess at regular intervals the adequacy of the institutional controls and, where such reassessment detects problems, to either address the inadequacies or reopen the remedy.

The Department is extending the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)-based Environmental Protection Agency land-use directive (issued on May 25, 1995) to Resource Conservation and Recovery Act (RCRA) corrective action so that reasonably anticipated future land use is identified early in the decision-making process on the basis of community input and factored into both risk assessment and remedy selection (E. Livingston-Behan, Department of Energy, personal communication, June 19, 1995).

INCENTIVES, METRICS, AND ACCOUNTABILITY

Like most federal agencies that do not face the market discipline that motivates private organizations, the Department and its contractors have only weak incentives for improved performance. Indeed, in a perverse way to the extent that budgets are allocated according to the magnitude and seriousness of the environmental problems faced by a site, liabilities become an asset. Likewise, with budgets tied to continuing containment and remediation processes, there is not as strong an incentive to complete projects as quickly as might be desired. Some even argue that the present structure of incentives rewards failure. An effort to improve incentives, metrics and accountability for federal employees and contractors would be the most effective way to improve the performance of the Environmental Management Program in meeting its goals, lowering its costs, and improving its safety in the short-term (see also pp. 147–149).

Disincentives within the Environmental Management Program must also be identified and eliminated so that environmental management goals and objectives can be reached. Internal operations and the integration of science, technology and engineering into the implementation of the goals of the Environmental Management Program are hampered by conflicting incentives that are unstated but understood by employees (see also pp. 74–75, 141–142). For instance, although instructed that projects need to be completed within specified periods, employees know from experience that the termination of a project can result in decreased funding for the program. Therefore, they might be led to preserve the program by failing to pursue means to accelerate the cleanup. It is necessary for the unstated goals to be recognized and incentives changed to support the stated goals of the organization; otherwise, employees will have conflicting incentives that undermine management objectives.

Another fundamental disincentive within the Department is that programmatic groups (e.g., those related to defense programs and fossil energy) do not budget for the management and disposal of the wastes that they generate (see also p. 107–108). The Environmental Management Program provides the service and funding for their wastes. Having the various programs of the Department ''pay'' Environmental Management for the services would provide an incentive for the programmatic groups to minimize waste and use appropriate technology.

The poor incentive structure within the Department carried over to its major contracts until very recently. The Department is to be commended for moving toward performance-based contracts. More should and can be done. Well-defined, carefully negotiated performance contracts can be expected to be much more cost-effective than cost-plus contracts. That change in contract administration should move Environmental Management toward managing its contractors by measuring their performance against desired outcomes, rather than by micromanaging their daily activities (see also p. 103, 153–154). The cost of remediation at Department facilities should be compared with similar activities in private industry and at other government agencies, such as the Department of Defense, to elucidate those differences in management (e.g., the creation of incentives) and procurement that might improve the Department's performance if they were adopted. Training of Department employees will be necessary to give them the skills needed for this new approach to contractor relations, as will a clear statement by Department leadership as to their expectations of the nature of that relationship (see also p. 144).

Environmental Management has recently tried an experiment in ''privatization'' of the vitrification of high-level nuclear waste at Hanford (see also p. 153). The effort is intended to place greater emphasis on performance by having the contractor bear even greater financial risk in case of failure to meet deadlines and regulatory compliance and to reap rewards for superior performance. There may be reluctance on the part of some states and localities to place as much faith in this new management approach as the Department. For example, while supporting the use of private companies to run the vitrification operation at Hanford, the Washington Department of Ecology and the citizen's Hanford Advisory Board believe this new initiative is too prone to failure and have urged the Department to be prepared to go more slowly and build the plant with Federal funds. It is too early to tell who is correct and if the marketplace will finance private companies to undertake tasks such as the vitrification of wastes at Hanford. If the opposition to new approaches such as privatization is based on the pursuit of unstated goals like providing continued employment and funding for a site, mechanisms should be found to create incentives for states and other stakeholders to willingly participate in these new management approaches.

In general, the Department's Environmental Management Program should use private-sector models and privatization to meet its objective. However, the models must be carefully adapted to suit the public-sector mandates. For instance, if privatization is selected by Environmental Management to accomplish its goals, the Department must recognize that it might have to supply mechanisms to encourage contractors to participate in this privatization, for example, guaranteeing a stream of revenue or allowing customers other than the Department to do business with the selected contractor. Environmental Management might have to create mechanisms to be responsive to the public, which might not release the government from responsibility for carrying out its mandates, regardless of contractual relationships. The Department should not lose sight of the fact that citizens will always hold it, not its contractors, as the party that bears the ultimate responsibility for its activities. That does not have to lead to micromanagement; it might require clearer performance standards or different contractual terms that do not depend on normal contractual remedies for breach of contract.

It is commonly said that civil-service regulations prohibit promotions in the absence of additional supervisory responsibilities and that it is difficult to remove people for poor performance and to reward people for good performance. It is possible to create a civil-service program that provides more incentives for performance (see also p. 148). Pilot programs of up to 5 years can be initiated by government agencies or other units. Environmental Management could implement a different promotion, reward, and firing pilot program. Programs could be modeled after successful industry and utility models. The use of teams for projects can supplement the normal organizational structure. The Department needs more technically knowledgeable people, including people trained in the field of public health, who are able to judge contractors' cost estimates within the context of the objectives set for the contract (see also p. 144). In industry, input by a multifunctional team consisting of a technical project leader, a lawyer, a finance manager, a corporate researcher, and government-relations, real-estate, and construction people starts at the beginning of a project and can continue through completion; the leadership of the team changes as needs change (see also p. 156). Teams are most effective if there has been training and awareness has been raised throughout the entire organization.

As the Department goes to more performance-based contracting, the lines of authority in the field will become blurred compared with the previous practice of cost-reimbursal contracting through field offices. All contracts let by Environmental Management should be administered by Environmental Management. Currently, there is a dysfunctional management loop in which goals are set by one manager (i.e., the Office of Waste Management which reports to the Under Secretary of Energy) and the responsibility for seeing that they are met rests in a different manager (i.e., the Associate Deputy Secretary for Field Management who reports to the Deputy Secretary) who has no direct input to the goal-setting process. Experience shows that control of all aspects of an operating contract under one line of management for its duration is much more effective than administration by multiple parallel lines of management (see also pp. 139–141). Using performance contracts should require fewer Department personnel during the operating phase than are currently employed.

Key to achieving changes in the operation of the Department's Environmental Management Program will be clear leadership from the Secretary. Secretary O'Leary has demonstrated leadership in taking actions to improve stakeholder involvement in the Program. She needs to continue that leadership and actively participate in the fundamental activities related to goal setting and improving the Department's performance as a regulated entity. She must also empower Department staff making cross-program decisions, and take a visible leadership role in decisions that require coordination with other departments, interagency forums, or the President.

GOALS AND PRIORITIES

Establishing a System for Setting Priorities

Any priority-setting system and its attendant tools must be placed in an overall organizational framework to be effective.

Congress usually specifies the *mission* for an agency in the legislation that define its programs and activities. In the case of the Department it has several missions as previously discussed and environmental management is integral to them all.

The *vision* provided by senior managers within the Administration and the Agency gives the agency, its staff, and the public an integrated look at the organization's future state. What does the agency want to accomplish? How does it want to view itself? How does it want the public to view it?

The *goals* are more specific targets for components within the vision, i.e., what specifically is the organization trying to achieve in the short and long term? For example, is Environmental Management trying to maximize the amount of Departmental land that will be available for public use? Is Environmental Management trying to contain waste/contamination and restrict land use to the maximum possible extent to minimize costs? Is Environmental Management going to have a comprehensive technology development program to reduce costs for waste management and environmental restoration activities? Goals are usually set after a dialogue between senior managers of an Agency who have helped formulate the vision and these within the agency who will have direct operational responsibility for accomplishing the goals. In the case of the Environmental Management Program the inclusion of stakeholders in this dialogue is essential.

Objectives are a series of more specific, short term, and quantifiable measures of accomplishment in pursuit of the agency's goals, missions, and vision. Goals may pertain to many facilities or activities, objectives will often pertain to single facilities or activities. Objectives provide answers to questions such as: What parts of each installation will be cleaned up with the intent of release to public use? What types of wastes will be accepted for storage or treatment at each installation? What will be the role of repositories as part of the long-range management of risks? Where will they be sited, what volumes of waste will they be able to accommodate, and in what order will they be received? What areas of the current complex will retain long-term access restrictions? What types of risks will be managed through long-term Department stewardship rather than complete remediation? Objectives are often set after a dialogue between managers of operations at specific Department sites and those who are responsible for achieving the goals. Again, the inclusion of local stakeholders in this process is critical to its success.

These are the main components of a coherent priority-setting system. However, their definition, no matter how rigorously accomplished, will not ensure that the system is effective or useful. This will require that at least as much attention be given to the following steps which are discussed in more detail under the section on implementation below.

The success of a priority-setting system ultimately depends upon how well it is actually *implemented*. For example, will the vision be achieved by Environmental Management dismantling all or selected Department production facilities? Should Environmental Management establish regional waste repositories for ultimate disposal of certain wastes? Should Environmental Management target technology development activities at the most costly and/or longer-term needs?

The Department needs to develop performance standards and metrics to measure as quantitatively as possible its performance and progress. How well does the organization perform and are its activities leading it to its goals? For example, what volume of waste material has been moved to a regional repository? What volume of waste has been adequately characterized? What cleanup levels have been established for contaminated materials on public lands? What is the quantity of land area available for public use? What is the level of potential exposure to Environmental Management's wastes?

The data on the extent of contamination that has been characterized to date are incomplete. Weighting factors are subjectively selected. Calculated probabilities and consequences are of limited defensibility. But none of these facts should be allowed to deter Environmental Management from the obligation to make decisions based on the knowledge, data and evidence at hand. The system should identify these limitations overtly. The presumption is that stakeholders will be receptive to such limitations and act on behalf of the national good.

Need for More-Specific Goals

The Environmental Management Program appears to understand its mission, and this is becoming apparent to the outside world. The Department needs to set specific goals as it asserts leadership in creating the environment to reach those goals. These goals include target cleanup levels, magnitudes of occupational risk to be tolerated, end uses of former Department facilities, and the role of repositories in the overall program. Processes already under way are intended to set many of the needed goals. However, these processes for establishing goals must be resolved as a *precondition* to developing a coherent approach to cleanup. This approach should allow priorities to be set, allow an effective cost-management culture to evolve, and allow decentralization of risk-management decisions back to the individual sites, where existing knowledge is sufficient to support sound decisions. Only when the Department is able to set clear and substantive goals unequivocally will it be able to spend money wisely to manage risks to workers, the public, and the environment and to instill confidence in the public and Congress. However, as further information is developed it may be that some of the goals are unattainable at a cost, risk, or social impact that society is willing to tolerate.

Some goals of the Environmental Management Program are unstated and sometimes conflict with stated goals. That has complicated and slowed the Department's efforts to achieve its long-term objectives for reducing risks for the public, workers, and the environment. For example, the stated goal of the Hanford cleanup is to reduce risk at the site in a timely and efficient manner. However, an unstated goal (except in casual conversation) is to provide continued employment and funding for the site. Organizational structures and decision-making by contractors and Environmental Management employees that would accelerate remediation or reduce the number of people required to carry it out might result in reduced employment or funding. Under the current system, states and local governments want to see rapid action toward achieving safer sites and safer operation, but they also want maximal employment at the Department's sites. Similarly, labor unions and contractors perceive a parochial benefit from larger and slower programs.

Attributes of a Priority-Setting System

A priority-setting system for Environmental Management should have the following attributes:

- *Consistency*. To be successful, the system must be used for a number of years. If it is good, future administrations will accept it; if not, it will be discarded. Congress has a key role in allowing the system to have some permanence. Different levels of funding will dictate different strategies for cleanup, which in turn can affect costs. For example, a budget that allows only containment and facility maintenance necessarily permits only urgent risks to be addressed. Projects that are expensive but smaller risks must continue in the Department inventory until urgent risks (some of which, like the Hanford high-level nuclear waste-tanks, will take considerable time to address) are resolved. The cost of monitoring and maintaining the less-risky sites remains high. At some higher level of funding, the strategy could change to include an aggressive effort to reduce these costs by removing lower-risk sites from the Department inventory as quickly as possible while the most-serious imminent risks continue to be addressed. The longer-term costs might be substantially reduced. If there is no predictability in funding, there can be no priority-setting system that implements a long-term strategy aimed at the highest possible cost-effectiveness.

- *Coherence throughout the Department's complex.* The priority-setting system must be coherent by being functional across the various Department sites and throughout the various elements of the Environmental Management Program. For example, the system must function in setting priorities within the portfolio of facilities that need decontamination and decommissioning just as it must function in determining whether the consolidation of storage sites for plutonium should have higher priority than decontamination and decommissioning of those facilities.
- *Feedback for evolutionary system.* The use of priority-setting tools within the priority-setting system (e.g., the Environmental Restoration Priority-Setting System and the Laboratory Integration and Prioritization System) should be evaluated regularly. Environmental Management generally needs to do more ex post analysis to improve its decision-making. Such processes encourage accountability of the Department's managers and contractors.
- *Clarity and transparency.* The goals and workings of the process should be clear to all participants and encourage the exchange of concerns to foster common conclusions. The methodology to quantify funding decisions must not have a hidden agenda.
- *Participation of stakeholders.* The legacy of low public trust and credibility of the Department was based, in the past, on the need for secrecy in some programs. The Secretary has taken steps to involve people affected by the Department's actions in the decision-making process. That has been successful and should be continued formally. Although stakeholders do not have authority to determine funding, they should participate in and understand the basis of funding decisions. The inclusion of Indian Nation, state, and local stakeholders in this process for fiscal 1997 is laudable.

Risk Assessment and Cost-Benefit Analysis

We recognize that Environmental Management, in response to a Congressional request, recently produced a preliminary evaluation of the risk of the many activities and facilities in the Environmental Management complex (DOE, 1995d). However, as its title suggests, this is only a first step.

Environmental Management should continue to develop a risk-based approach by having risk assessment done as one of the major activities under the Environmental Management umbrella. That is especially useful when priorities must be set and decisions about worker, public, and environmental health must be balanced against each other and against costs. The process should be open so that the results will be understood by both the Department and stakeholders. It should undergo extensive peer review by outside panels. The assessments, which will take several iterations to perfect, should compare the risks at the several major sites to enable prudent allocation of resources and to decide which sites should be approached first (NRC, 1994).

Ultimately, the process should be able to identify the locations and situations that pose the most serious risks to the public, to workers at Department sites, and to the environment. Imminent risks should have the highest priority for action. For nonimminent risks, risk assessment should identify the benefits of risk reduction as part of overall cost-benefit analyses, which should form the basis for further priority-setting and resolution of contamination problems that must be addressed as required by law or compliance agreements.

A cautionary note on the use of risk assessment, cost-benefit analysis, and other tools used in priority-setting is necessary. These tools are just that, tools for the manager and stakeholders to use in the decision-making process. They are only as good as the information that is used in performing the analysis and ultimately, there are many factors which might affect the decision-maker outside of these data-driven tools.

SCIENCE AND TECHNOLOGY

Science and technology play key roles in virtually all activities of Environmental Management. They help to determine priorities for site cleanup by providing a basis for sound risk assessments and provide the tools for reaching remediation goals and priorities and ensuring that actions of the Department are the best that can be done. For environmental management problems that lack good solutions, Environmental Management needs an effective way to bring Department and other scientific and technical resources to bear. The Department must dramatically improve its research and technology-development outreach. That can be accomplished only by widely opening the Department's research and development program to all qualified professionals and organizations, regardless of type or location (including international expertise). Concomitantly with opening the Environmental Management R&D procurement system, a broad-based system of external peer review must be carefully implemented and monitored to ensure that the best proposals are selected.

Focus Areas

Environmental Management has designated five priority or Focus Areas for technology development. The purpose of the focused approach is to bring together users and developers to decrease cost, decrease risk, and develop ways to do what cannot be done today. In addition, a number of cross-cutting or common subjects have been identified by the Department for special attention: characterization, monitoring, and sensors; efficient separation and processing; robotics; and technology transfer.

Keys to the success of the Department's technology development process are that it be intimately linked with identified customer needs (i.e., the site-specific application of the technology) and that it use quantitative tools, such as risk analysis and cost-benefit analysis. The process of technology selection must also be iterative so that technologies under development reflect recent advances. The committee believes that the Focus Areas that have been defined provide an appropriate structure for using these approaches. However, we are concerned that implementation of the focus approach has fallen short of the intended mark primarily because users, researchers, and developers have not yet been fully integrated into the decision-making process for selecting new technologies. We recommend that steps be taken to ensure that user involvement in the focus approach is substantial enough (and has sufficient expertise) to affect the early selection and continued refinement of technologies for development.

National Laboratories, Universities, and Industry: Partnerships and Competition

The decision as to whether National Laboratories, universities, or industry should take the lead in a basic-research effort or in the development of any particular technology should be based on a competitive process that undergoes external review, not on formula or some other form of entitlement. Teaming together and partnering these different groups is often the most-effective approach.

National Laboratories constitute an extraordinary technical resource both in capability and in size. It must be recognized, however, that the Laboratories are unique in culture and expertise (especially with nuclear materials), which can be both an advantage and a disadvantage in bringing new technologies and science to bear in Environmental Management's activities. There must be strong external benchmarking and extensive peer review of research and technology-development efforts in the National Laboratories. The Laboratories must also be open to procurement of outside capabilities even when the main body of the R&D takes place inside. As with all participants in the technology-development effort, the Laboratories should structure efforts to be responsive to the technology needs of customers.

Experience has demonstrated time and time again that the National Laboratories are most effective at producing technologies that have potential for commercialization if they are linked to industry at the earliest possible time. The idea is for industry to provide ''technology pull'' that can guide the R&D so that the product meets customer requirements and there are no surprises when the technology is turned over to industry for commercialization.

REGULATORY MEASURES

External Regulation

The Department is subject to external regulation and in some particulars is self-regulating (see also p. 34). There is an inherent tension (many would say a conflict of interest) between meeting primary mission requirements (e.g., dismantlement of the nuclear weapons arsenal) and ensuring adequate protection of worker safety, public safety, and environmental concerns. Because of that tension, regulatory systems in which the entities regulate themselves lack credibility. Given the magnitude of the risks associated with manufacturing and in maintaining and dismantling the nuclear weapons stockpile, effective and credible external regulatory programs are necessary. We believe that the Department's self-regulation of its nuclear-related activities should be eliminated. We are not prepared to recommend an appropriate successor agency for the Department's current regulatory roles, but clearly one would be needed. This Subcommittee is aware that any transition from self-regulation to external regulation will be difficult in view of the very specialized and complicated issues which the Department faces. This transition should be done cautiously and carefully.

Overcoming Regulatory ''Obstacles''—Using Existing Flexibility

In a number of instances in which the Department and its contractors cite regulatory restrictions as prohibiting common sense and safe solutions to their problems, there is usually some form of regulatory flexibility that has not been applied. The Department should increase the use of the flexibility that is available in the regulations (see also pp. 35, 111–112). Obtaining variances, waivers, or their functional equivalents in threshold standards, treatment requirements, and groundwater monitoring are examples of such flexibility. Industry often works with regulators to find mutually acceptable compromises in the face of regulatory restrictions. The Department should encourage Environmental Management and its contractors to use the available flexibility. The focus of the Department and its employees should be on achieving long-term goals, not on meeting the detailed schedules of current compliance agreements where they are in conflict with these goals. In cases where these conflicts arise and remediation is impeded, the Department should seek to renegotiate the compliance agreement.

Streamlining Regulatory Measures

The current regulatory system is a confusing patchwork assembled, at least in part, with weapons production in mind (see also p. 47). A number of potential problems are caused when the authorities of multiple regulators, such as states, the Defense Nuclear Facilities Safety Board, and the Environmental Protection Agency (and sometimes the Department), for cleanup of a given site or operable unit overlap. The problems include the following:

- When there is lack of agreement among multiple regulators, regulatory compliance is slowed to attain a consistent decision.
- Additional resources are expended in coordination.
- Differences between the objectives of multiple regulations inhibit priority-setting.

Lead Regulator

If more than one regulatory entity, including state and federal agencies, has jurisdiction over a Department site, a lead regulator should be designated for a cleanup activity or group of cleanup activities and every effort should be made to have as few different regulators at a site as possible (see also pp. 37–39). The lead regulator should oversee all day-to-day compliance or cleanup actions and decisions and should resolve disputes. Other regulators on a site should recognize and defer to the authority of the lead agency. The mechanism for achieving this goal could be its incorporation into existing compliance agreements.

Other measures that would streamline the regulatory process for Environmental Management include

- Early involvement between the Department, its regulators, and other stakeholders in scoping out projects and budgets for compliance agreements.
- Permission for site cleanups to occur under RCRA closure or corrective action in lieu of CERCLA where both RCRA and CERCLA are applicable.
- Encouragement of use of the ''one document'' approach to satisfy RCRA and CERCLA.
- The functional equivalence of RCRA to NEPA where RCRA applies, as NEPA and CERCLA have been integrated to be functionally equivalent where CERCLA fulfills NEPA.
- Cross training of regulatory Department, and contractor personnel in applicable laws.
- Delegation of CERCLA to states. There are a number of approaches as

to how this could be done. States could be mandated to require exactly what is currently required of those regulated by the federal regulators with jurisdiction over CERCLA or states could be permitted to have more stringent requirements than current federal regulations.

PUBLIC PARTICIPATION: SEARCHING FOR CONSENSUS TO ACHIEVE CREDIBILITY

A Department decision that is supported by sound scientific and technical understanding will not necessarily lead to a successful result. High-quality scientific and technical information is of little value in decision-making if it is not understood and accepted by stakeholders. The challenge for Environmental Management managers is to bring together a variety of factors into a well-balanced, implementable decision. The call for all Departmental efforts to be open and transparent to stakeholders recurred throughout the work of this committee's four subcommittees. Whether the issue is the decision process for technology selection or the performance of a risk assessment for remedial-action options, involving stakeholders is crucial for creating workable consensus. The Department operates in a political environment in which citizen support is essential to avoid costly and protracted litigation or similar consequences. Consensus is the key to credibility in this political environment. Without credibility, little will be accomplished by Environmental Management in reaching its vision or in completing its mission.

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Part II

Evaluation of Regulatory Measures

SUBCOMMITTEE ON EVALUATION OF REGULATORY MEASURES

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Introduction

This is the report of the Subcommittee on the Evaluation of Regulatory Measures. Biographical information on the members is provided in the appendix. The letter from Mr. Grumbly, mentioned above, indicates that this subcommittee's work should examine how the performance of the Environmental Management Program could be improved through regulatory measures, such as new statutes, revised statutes, and revised regulatory agreements.

Our workshop was held on June 19–20, 1995, in Washington, D.C. The workshop agenda and list of participants are included in the appendix. We heard presentations from representatives of DOE headquarters, DOE sites, contractors at DOE sites, Environmental Protection Agency (EPA) headquarters and EPA regions, the Nuclear Regulatory Commission, state attorneys general, state environmental agencies, and others. A roundtable discussion was held after the formal presentations to explore some of the relevant issues further. The participants identified what they considered to be the most important matters to address. We used the results of the roundtable discussion as a springboard in developing a framework for this report and for identifying important issues that we might address.

DOE's environmental restoration activities must be conducted pursuant to applicable environmental laws. The principal environmental laws dictating how the cleanup is to be performed at the weapons sites are the Resource Conservation and Recovery Act, as amended (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act, as amended (CERCLA) (also known as Superfund), and the Atomic Energy Act of 1954, as amended. Many DOE sites are on the National Priorities List (NPL) developed under CERCLA. The National Environmental Policy Act (NEPA) of 1970 mandates that all federal agencies and departments take into consideration the adverse effects that their actions might have on the environment. NEPA requires that agency actions be reviewed early in the planning process and that the process be open to public participation. DOE's environmental-restoration efforts are also subject to state laws and regulations, including those adopted under the authority of RCRA and CERCLA.

All high-level radioactive waste and most transuranic waste are mixed waste, usually because of the presence of organic solvents or heavy metals, in addition to the radioactive components. The hazardous component of mixed waste is regulated under the RCRA. In 1992, Congress passed the Federal Facility Compliance Act, which amended RCRA to make federal facilities subject to the same fines and penalties as any private corporation if they violate the law. The law also requires DOE to develop plans for mixed-waste treatment, subject to approval of the states or the U.S. Environmental Protection Agency (EPA).

For sites that are required to undergo CERCLA cleanup, DOE is required to enter an agreement with EPA regarding how the cleanup should be carried out. EPA has states join in these compliance agreements. Thus, the agreements are often signed by three parties: DOE, EPA, and the state where the facility is. Compliance agreements are also formed with regard to requirements under RCRA and when both CERCLA and RCRA apply. Compliance agreements must include at least a schedule for accomplishing the cleanup, arrangements for operation and maintenance of the site, and a review of the cleanup options considered and the remedy selected. Such agreements are enforceable by states against DOE facilities, and civil penalties may be imposed for failure or refusal of a facility to comply with a compliance agreement. State enforcement under CERCLA agreements occurs through citizen suits, but states have separate enforcement authorities. Compliance agreements might give additional authority from multiple statutes, and enforcement provisions vary because of the construct of the agreement and the underlying regulations.

Sites that have not been placed on the NPL operate only under the regulatory jurisdiction of RCRA. A major difference between CERCLA and RCRA is that CERCLA coverage includes both hazardous and radioactive contamination, whereas RCRA and its corrective-action provisions cover only hazardous waste and the hazardous portion of mixed waste. Releases of radioactivity to the environment are regulated exclusively by DOE under the authority of the Atomic Energy Act. DOE has its own set of internal directives (DOE orders) governing radioactive-waste management and the limitations of radionuclide releases to the environment. The Atomic Energy Act gives DOE broad authority over radioactive waste with the exception of facilities for the storage and disposal of high-level radioactive waste and spent nuclear fuel, which are regulated by the Nuclear Regulatory Commission. Thus, DOE orders are wide-ranging and include environmental protection, worker safety, project management, facility design, transportation, emergency planning, and personnel. In addition, each DOE contractor independently maintains its own sets of guidance documents and internal procedures to implement these orders.

According to DOE's 1995 Baseline Environmental Management Report, the life-cycle cost estimate for DOE's Environmental Management Program ranges from $200 to $350 billion in constant 1995 dollars, with a midrange estimate of $230 billion. That included not only the $172 billion for dealing with the nuclear-weapons complex legacy, but also $24 billion for future wastes from nuclear-weapons activities and $34 billion for past and future wastes from other activities. The projected cost for treatment, storage, and disposal of waste generated by continuing defense and research activities is $19 billion. The large projected cost for support of future continuing programs indicates the value of vigorous pollution-prevention efforts to reduce costs and threats.

The base-case cost estimate begins in 1995 and ends in about 2070, when environmental-management activities are projected to be substantially completed. The estimate does not include amounts expended since the program's formal inception in October 1989—about $23 billion—or costs incurred before 1989. Nor does it include costs beyond 2070 for long-term surveillance and maintenance, which are estimated at about $50–75 million per year. Those costs are assumed to continue indefinitely after a disposal site or restricted-access area is closed.

DOE's Environmental Management program and regulatory measures have been assessed by a number of organizations. The appendix includes summaries of relevant documents prepared by various organizations and individuals.

Our Approach to Evaluating Regulatory Measures

We focused our deliberations on regulatory statutes, regulations, and their implementation regarding environmental remediation and waste management in DOE's Environmental Management Program. Our emphasis has been on public health. Related issues, such as exposure of workers involved in environmental cleanup, are being addressed by the Advisory Committee on External Regulation of Department of Energy Nuclear Safety. That advisory committee is an independent review panel that will recommend whether and how DOE nuclear facilities and operations might be externally regulated to protect health, safety, and the environment, to eliminate unnecessary oversight, and to reduce costs.

In this report, we first discuss the principles that guided our deliberations. Next, we address regulations within DOE, multiple external regulators, land-use planning, standards for residual risk, and considerations of cost effectiveness and risk. We conclude with what we consider to be our principal recommendations.

We developed the following set of principles to guide our deliberations. We believe that DOE and its regulators should develop a corresponding set. These principles are based upon input from workshop participants and our judgment. Many of the principles are discussed later in the report in the context of relevant conclusions and recommendations.

- Public sites, including those of DOE, and private sites should be treated similarly by regulatory measures, and expected outcomes should be the same where the problems are similar. (However, DOE sites provide an opportunity to demonstrate new technologies that private parties might not want to attempt at private sites.)

- A lead regulator, whether a federal or state agency, would expedite the resolution of regulatory problems. Once the lead is established, flexibility inherent in existing regulations should be used to improve outcomes. Because sites are diverse, it would be inappropriate to develop a one-size-fits-all regulation.
- Because many needs compete for scarce resources, it is essential to strive for cost-effective environmental management for health, safety, and the environment. But protection of health, safety, and the environment must be the paramount consideration that drives DOE's EM activities.
- Interim remedies for contaminated sites, such as land-use controls, should not be considered permanent, because residual risks can be very long-lived. However, when such remedies offer cost-effective means of protecting public health and communities are willing to maintain them, they should be pursued. It is important to continue to seek permanent remedies, but their absence is no excuse for inaction.
- Full dialogue among stakeholders, including state regulators, should be pursued before decision-making.
- Regulatory goals should be adopted on the basis of priorities set through an open, public process that focuses on protecting workers, public health, and the environment. Efforts to meet future milestones should also have this focus. Such an approach can aid in gaining stakeholder acceptance and the development of shared goals between the regulator and the regulated. Therefore, the focus should be on achieving long-term goals, not on meeting the detailed schedules of current compliance agreements. In cases where these conflicts arise and remediation is impeded, the Department should seek to renegotiate the compliance agreement.
- The focus should be on improved implementation of existing regulatory measures; development of new legislation should be considered only secondarily.

Regulation of DOE's Environmental Management Program

From the beginning of the Manhattan Project until after 1970, DOE and its predecessors were not subject to external regulation. Beginning in the 1970s, federal legislation waiving the federal government's sovereign immunity from state and federal environmental laws was enacted. DOE resisted the application of hazardous-waste regulation for several years. That resistance resulted in a 1984 federal court decision (*L.E.A.F. v. Hodel*) rejecting DOE's contention that RCRA did not apply to its activities because it would conflict with the Atomic Energy Act. In 1987, DOE acknowledged that RCRA applied to the hazardous-waste component of mixed radioactive and hazardous wastes.

In the late 1980s, DOE's operations rapidly went from having virtually no oversight to being the subject of multiple internal and external reviews, including a highly publicized criminal investigation at Rocky Flats that resulted in a plea agreement in which DOE's contractor pleaded guilty to 10 criminal counts under 2 federal environmental laws and paid an $18.5 million fine. Such intense scrutiny resulted in a dramatic change in DOE's attitude toward compliance with its own orders and with external regulations. Suddenly, DOE became overconservative, in the bureaucratic sense, in interpreting regulatory requirements. At the same time, it began to place great reliance on its contractors in determining how to comply with regulatory requirements (both externally imposed requirements and DOE orders). Combined with a lack of sufficient properly trained contract managers and the prevailing use of cost-plus contracting mechanisms (which create financial incentives to increase costs of compliance), DOE's overconservative approach has led to substantial inefficiencies and unnecessary costs in complying with environmental-protection and nuclear-safety requirements.

Also in the late 1980s, DOE shut down portions of the nuclear weapons complex until a series of safety and environmental problems could be resolved. While those facilities were shut down, the Cold War ended, and DOE decided that some of them (e.g., those at Hanford and Rocky Flats) would not be reopened. The widespread safety and environmental protection concerns at its facilities prompted DOE to re-examine its policies regarding self-regulation and its approach to external regulators (i.e., state and federal environmental regulators).

DOE AS AN EXTERNALLY REGULATED ENTITY

We found that DOE has experienced considerable difficulty in making the transition from operation in an environment in which it was largely self-regulated to a much more open atmosphere with substantial external oversight. DOE has made substantial progress in becoming more open, but its success in adjusting to external regulation has been uneven, in part because of the events that surrounded the first serious efforts to impose external regulatory requirements on DOE, discussed above.

To its credit, senior management of DOE has recognized the shortcomings in its contracting practices. It has hired many federal employees to provide better contract oversight, and it is rebidding many of its contracts to emphasize cost-effective compliance. As noted below, DOE is also in the process of promulgating its orders as rules and in so doing has established a decision-making process for determining the necessary and sufficient requirements that must be established to comply with the new regulations case by case. Those reforms should help to reduce DOE's costs of environmental protection, worker-safety, and nuclear-safety compliance. DOE's progress in implementing the reforms should be monitored to ensure that it achieves its goals.

However, many state and federal regulators have observed that DOE seems not to know how to ''work with'' regulators. In particular, outside regulators have repeatedly expressed concerns over DOE's failure to communicate with them in a timely manner regarding compliance matters. That failure inhibits regulators from assisting DOE in complying with regulatory requirements in a common-sense, low-cost fashion, for example, by pointing out overconservative regulatory interpretations. Failure to communicate in a timely fashion might also delay DOE's compliance with regulatory requirements in particular situations.

SELF-REGULATION

We think that the weaknesses of a system of self-regulation are plain: there is an inherent tension (many would say a conflict of interest) between meeting ''primary mission'' requirements (e.g., rapid buildup of nuclear weapons arsenal) and ensuring adequate protection of worker-safety, nuclear-safety, and environmental concerns. Any regulatory system must rely in part on voluntary efforts to comply, but external enforcement is also necessary to ensure a consistently high compliance. Because of that inherent tension, regulatory systems in which the entity responsible for compliance is also responsible for enforcing compliance lack credibility. Given the magnitude of the risks associated with manufacturing and maintaining the nuclear weapons stockpile, effective and credible regulatory programs are necessary.

We agree that DOE's self-regulation of its nuclear-related activities should be eliminated. Indeed, DOE has established the Advisory Committee on External Regulation of Department of Energy Nuclear Safety to provide advice specifically on how nuclear-related activities at DOE facilities might be regulated.

DOE ORDERS

In addition to the general problems of self-regulation, DOE and others have identified a number of problems with the particular system of ''DOE orders'' that DOE and its predecessors had developed to implement the requirements of the Atomic Energy Act. The orders were not developed in a coordinated manner and were never promulgated as regulations under the Administrative Procedures Act (APA). They often failed to establish clear requirements, and there was no administrative process for determining how each order should be applied to a particular activity. Consequently, many of the orders were essentially unenforceable and generally were not enforced. Recently, DOE began reviewing its orders, rewriting them, and promulgating them under the APA to address those concerns. We support DOE's process of reviewing its orders and converting them to rules that have a clear legal foundation; this should increase the clarity of obligations placed on contractors and provide a clear mechanism for enforcing obligations. However, conversion of DOE orders to promulgated rules is not an adequate solution to the problems created by self-regulation. The reason is that the purpose of the orders (and of the new regulations) is to increase contractors' accountability to DOE. They do not (and cannot) address the lack of DOE accountability to the public and affected communities by self-regulation.

We also support elimination of orders that are redundant with outside authorities, obsolete because of their focus on the past production mission, or overprescriptive. In addition, DOE should hold its contractors responsible for conducting similar reviews of internal procedures intended to implement DOE orders so as to streamline the entire system.

MULTIPLE REGULATORS

As noted above, we agree that DOE's self-regulation of its nuclear-related activities should be eliminated, it is necessary to make a transition to external regulation, and we are not making specific recommendations regarding who should assume the responsibility for such external regulation. However, we note that the manner in which external environmental regulation has been implemented has contributed to the creation of multiple regulators and overlapping regulatory requirements for some activities, including management of mixed radioactive and hazardous wastes. If done poorly, moving to external regulation of nuclear safety could complicate this situation. There is some degree of communication between entities with overlapping responsibilities (DOE and the Defense Nuclear Safety Board on the one hand, and state and EPA hazardous-waste regulators on the other), but no formal mechanisms have been developed to coordinate implementation of these regulatory systems. In providing for external regulation of DOE nuclear safety, care should be taken to ensure coordination with hazardous-waste and related regulatory programs, particularly with respect to mixed waste.

In our view, external regulation would give public credibility to DOE and hence facilitate efforts to move forward with the EM mission. However, the current regulatory system is a confusing patchwork assembled, at least in part, with weapons production in mind. A number of potential problems are caused when the authorities of multiple regulators, such as states and EPA (and sometimes DOE), overlap for cleanup of the same site or operable unit. For example:

- When there is lack of agreement among multiple regulators, regulatory compliance is slowed to attain a consistent decision.
- Additional resources are expended in coordination.
- The presence of different objectives of multiple regulations inhibits priority-setting.

CURRENT ACTIVITIES

Several isolated efforts are under way to address the problem of multiple regulators. Such efforts include:

- An effort sponsored by EPA and DOE to increase consistency of cleanups performed under RCRA and CERCLA and to provide better integration of the two statutes.
- State agreements with EPA in dividing the workload at the Hanford facility to strive for a single regulator on one project.
- DOE review of orders from headquarters.
- The Hazardous Waste Identification Rule, proposed by EPA, which is

intended to provide exemptions from RCRA Subtitle C waste-management requirements for low-toxicity hazardous wastes that are managed in a way that is protective of human health and the environment and which includes consideration of mixed radiologic and RCRA hazardous waste (mixed waste).

- The Corrective Action Management Unit Rule (an RCRA regulation), promulgated by EPA and adopted by a number of states, which allows more site-specific, tailored management of cleanup wastes than had been the case under RCRA (for example not requiring compliance with ''land-disposal restriction'' treatment requirements and not requiring that remediation wastes be placed in a landfill that meets RCRA's ''minimum technological requirements.''
- DOE's suggestion to Congress (in response to the Speaker's Task Force on Nuclear Cleanup and Tritium Production (1995) referred to as ''turbocharge'') that a national policy be set for streamlining the cleanup requirements of RCRA and CERCLA, including several specific options.
  - —Dividing the workload between regulatory agencies and setting out a unified approach to meeting RCRA and CERCLA requirements.
  - —Prohibiting states from exercising RCRA corrective action authority at federal sites on the National Priorities List (NPL).
  - —Requiring EPA to remove a federal site or operable unit from the NPL if a state imposes corrective-action requirements at the same facility or operable unit.

POSSIBLE COMPREHENSIVE SOLUTIONS

We recommend the following solutions for problems caused when the authorities of multiple regulators overlap for the cleanup of the same site or operable unit. Some of the solutions would involve administrative changes in how existing laws are implemented. Other solutions would require statutory changes.

- Increase use of flexibility currently available in the regulations, e.g., obtaining variances, waivers, or their functional equivalents in threshold standards, treatment requirements, and groundwater monitoring.
- Designate a lead regulator for each cleanup activity or group of cleanup activities. The lead regulator would oversee all day-to-day actions and decisions and resolve disputes. Other regulators on site would recognize the authority of the lead agency and defer to it.
- Involve DOE, its regulators, and other stakeholders early in scoping out projects and budget for compliance agreements.
- Allow site cleanups to occur under RCRA closure or corrective action in lieu of CERCLA when both RCRA and CERCLA are applicable.
- Encourage use of ''one-document'' approach to satisfy RCRA and CERCLA.

- Just as NEPA and CERCLA have been integrated to be functionally equivalent where CERCLA fulfills NEPA, make RCRA, where it applies, fulfill the requirements of NEPA.
- Cross train regulators, DOE, and contractor personnel in multiple laws.
- Allow CERCLA to be delegated to states by requiring them to follow exactly what is required in CERCLA or allow states to have their own cleanup program, which might or might not be allowed to be more stringent than federal requirements when regulatory authority is delegated to states, mechanisms would be needed to ensure that they are adequately and cost-effectively performing their regulatory function.

Responsible Stewardship

We have taken as a guiding principle that lack of appropriate technology or a permanent solution for remediating a polluted site or facility should not be an excuse for taking no appropriate steps on a near-term or interim basis and is not an excuse for inaction. Responsible stewardship means furthering protection of the public and the environment by undertaking near-term or midterm action to remediate a site when no permanent solution exists. Communities and states that are willing to make institutional commitments to implementing plans for near-term and midterm remedies are participating in responsible stewardship. In the absence of permanent solutions, responsible stewardship is desirable because it allows progress to be made by providing adequate protection against environmental and human-health risks that are serious and long-lived. It deals with waste in relatively short periods, say, 20 years. After such a period, existing approaches should be re-examined, and society can decide what to do with site cleanup for the next 20 years. Until permanent solutions are developed, irreversible actions should be avoided. Furthermore, the benefits of actions considered over the short term should not obscure the benefits of long-term solutions. If many 20-year periods are considered together, the costs of taking only the short-term view could be huge.

Decisions about contamination along the Columbia River at Hanford illustrate the idea of responsible stewardship. Stakeholders have placed a high priority on unrestricted access to lands along the river. Stakeholders have also acknowledged that no near-term solution exists for complete remediation of the underlying groundwater. So work has focused on the remediation of soils and on remediating and containing sources of groundwater contamination while retaining the long-term goal of unrestricted use of the groundwater.

Another example is the management of transuranic waste at the Idaho National Engineering Laboratory. Recently, DOE has undertaken a major effort at consolidating, repackaging, monitoring, and sheltering its transuranic waste. Instead of being exposed to the effects of weather and the risk of corrosion and leaks, drums containing transuranic waste are stored on concrete or asphalt pads under weather-resistant structures. Much of the waste had been stored in earth-covered berms, which were expected to be needed for only a few years, until a permanent disposal site became available. DOE is now repacking drums that began to corrode or leak and is building new interim storage facilities (DOE, 1995a).

Responsible stewardship should not be relied on to provide permanent solutions. Some components of radioactive waste can continue to be a threat to human health and safety for thousands of years or more. A National Research Council report (NRC, 1995) concludes, for high-level nuclear-waste disposal, that although it might be reasonable to assume that a system of interim safeguards can be relied on for some period, there is no scientific basis for assuming the long-term effectiveness of institutional controls to protect against releases of the stored radioactive materials.

Land-Use Planning

Many contaminated sites and facilities could be restored to a pristine condition, suitable for any desired use; or they could be restored to a point where they pose no health risks for some uses (e.g., industrial development or recreation). In other cases when permanent remedies are unavailable, the surrounding communities could be protected for the near future by fencing off the sites and facilities. Each of those options is associated with its own set of costs and benefits. Land-use decisions like these are relevant to the consideration of regulatory measures in that different cleanup-level goals might be set for different land-use options with little or no difference in risks to human health.

DOE believes that current efforts at land-use planning and the mechanisms for their implementation are inadequate. In cases not bound by legal obligations or commitments by DOE, future land use is unclear. DOE has begun working with stakeholders and regulators regarding the ultimate disposition of lands currently managed by DOE (DOE, 1995b).

We believe that land use and groundwater impact should be among the first considerations in planning remediation. Furthermore, there is a need for a formal decision framework for future land-use and cleanup standards. The framework must include an opportunity for input from all interested parties including Indian Nations and other affected communities. It would be used to develop enforceable but modifiable agreements.

If land-use restrictions are to be incorporated in cleanup remedies for DOE sites, there must be clear assurance that the land use will be controlled for the duration of the contamination. This is a serious problem for sites contaminated with long-lived radionuclides. The record of decisions in selecting the remedy should incorporate specific commitments by DOE designed to maintain the necessary institutional controls over the lifetime of the contamination. Where contaminants are so long-lived that such commitments are impossible, the remedy should include specific procedures designed to reassess regularly the adequacy of the institutional controls and, where such reassessment detects problems, either to address the inadequacies or to reopen the remedy.

DOE is extending the CERCLA-based EPA land-use directive (issued on May 25, 1995) to RCRA corrective action so that reasonably anticipated future land use is identified early in the decision-making process on the basis of using community input, in both risk assessment and remedy selection (E. Livingston-Behan, DOE, personal communication, June 19, 1995).

A National Research Council report (NRC, 1994) recommends that three levels of site remediation be considered with respect to risk (imminent and long-term) and cost as part of a process for setting remedial-action priorities for contaminated sites. The three levels are sufficient remediation to contain contaminants so that they would not present substantial risk to human health and the environment, restoration of a site to the point where no land-use restrictions would be necessary, and restoration to return the site to precontamination quality. Such consideration would allow sound judgments to be made concerning the degree of cleanup that should be pursued at a given site. It would indicate when more extensive cleanup at a site might not involve substantially more cost than containment.

Residual-Risk Regulation and National Cleanup Standards

Although the general goal of environmental restoration is cleanup, there is no universal answer to the question ''How clean is clean enough?''. Cleanup under CERCLA is considered complete if federal and state cleanup standards are met. Standards exist for drinking-water supplies (protection of human health) and surface waters (protection of ecosystems). Few such standards exist for soils, even with respect to hazardous chemicals, and no standards have been designed specifically for cleanup of most radionuclides in soil. The only standards designed for the cleanup of radionuclides are those for land and buildings contaminated by uranium-mill tailings at inactive uranium-processing sites.

Under CERCLA, risk assessments are conducted to determine the relationship between contaminant concentrations at an affected site and the likelihood of adverse effects on human health and the environment. Cleanup levels are established by calculating the expected lifetime cancer risk from the risk estimates, as well as by compliance with applicable or relevant and appropriate requirements (ARARs).

In an effort to remedy the lack of consistent radiation-cleanup standards, the EPA and the Nuclear Regulatory Commission are developing the Radiation Site Cleanup Regulation (40 CFR 196) and Radiological Criteria for Decommissioning (10 CFR 20), respectively. These requirements will apply to DOE sites. An EPA and Nuclear Regulatory Commission memorandum of understanding (57 FR 54127) discusses how the two agencies' parallel approach will yield regulations that are consistent, are protective of public health and the environment, and are issued in a timely manner.

There needs to be a standard framework for acceptable risk vis-a-vis land-use and water-use categories that gives stakeholders leeway within a fixed range of permissible risk. Such a framework would be used as a point of departure for site-specific considerations. It would permit flexibility for cleanup above or below the standard. Decisions would be made with the understanding that new knowledge (concerning toxicity, migration, or innovative technology) could trigger revisiting of cleanup plans.

Cost Effectiveness and Risk Considerations

Resources are scarce and contested, so advocated solutions should be well justified regarding cost and should be related to risk. It is most useful to consider cost effectiveness and risk at the macroscopic level to identify points of gross disparity among site-cleanup efforts. Such a consideration would be one of several tools in making decisions. Other tools are considerations of land use and cultural, social, and economic factors. The benefits of a remedy that is selected as protective, practical within time and technical grounds, and acceptable to the affected community should bear a reasonable relation to its cost. It would be very time- and resource-consuming to justify cost and risk-benefit relationship in an elaborate, quantitative way. Given the many assumptions required for such an analysis and the resulting uncertainties, it would be infeasible to establish that a particular course of action is the least-cost alternative.

Overall Findings and Recommendations

STREAMLINING THE REGULATORY PROCESS

In most instances, difficulties arising from the overlap of regulations are due not to the statutes as written, but to differences in how the standards are implemented and in the numerous parties involved in their application. With the specific exceptions noted in this report, legislative changes are not necessary for DOE to move forward with an effective, efficient cleanup. The department should focus its attention on the administrative and organizational changes noted in this report, which are likely to pay off in a better program.

Regulators need one of them to be in the lead and to be a spokesperson and need to rely on flexibility in the current regulations. However, streamlining efforts must be handled carefully to avoid cutting people out of the process. Streamlining should be used not as a means of vitiating regulatory measures, but as a means of facilitating their implementation and compliance.

Streamlining compliance agreements is especially important. In some cases, such agreements tend to be too prescriptive. Milestones are set at every step and add too much cost for the incremental environmental value. A rigorous schedule makes it difficult to accommodate budget realities. However, in the absence of milestones or with excessive flexibility (e.g., 5 years or more) for meeting them, it is possible that no real progress would be made.

Milestones in cleanup agreements should focus on major outcomes or results and allow for flexibility in reaching them. The milestones should be performance-based and adjustable where appropriate.

RESPONSIBLE STEWARDSHIP

Responsible stewardship, as discussed above, is a reasonable way to address the cleanup problem when permanent solutions are unavailable. It is the antithesis of delay, in that it promotes progress instead of inaction. Responsible stewardship requires the use of mid-term remedies so that progress can be made in protecting human health and the environment now and in the future. It deals with waste in relatively short periods, say 20 years. After such a period, society can decide what to do with site cleanup for the next 20 years. However, the benefits of actions considered over the short term should not obscure the benefits of long-term solutions. If many 20-year periods are considered together, the costs of taking only the short-term view could be huge.

As mid-term remedies are put into place, it is important for DOE to continue developing permanent solutions to problems that resulted from past mistakes. In addition, responsible stewardship should promote waste-minimization and waste-reduction efforts to avoid repeating mistakes with newly generated waste.

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Appendix

VARIOUS PERSPECTIVES ON DOE'S ENVIRONMENTAL MANAGEMENT PROGRAM

This appendix was prepared by National Research Council staff to summarize relevant documents prepared by various organizations and individuals. The summaries focus on the regulatory aspects of the reports and are not intended to be comprehensive. The subcommittee has made no attempt to identify the reports with which it agrees or disagrees.

Blueprint for Action and Cost Control at Hanford (May 3, 1995) summarizes the results of a meeting held on April 26–27, 1995, by the senior managers of DOE (headquarters and Richland), EPA (headquarters and Region 10), the Washington state Department of Ecology, and the major contractors (Westinghouse and Bechtel). The meeting addressed how to manage the cleanup of the Hanford site. Participants discussed ways to cut costs and increase the efficiency of regulatory measures. Five major kinds of action for the redirection of the Hanford cleanup were identified:

- Using a project-management approach that rewards action, promotes accountability, and controls costs. This could be accomplished by breaking up large projects into smaller discrete packages, tightening the chain of command, moving to performance-based incentives, and making project managers responsible for scope, safety, cost, and schedules.

- Reducing costs and increasing competition. Site contractors would use performance-based, fixed-price, and other incentives to control costs and maximize performance.
- Tracking and reporting cost savings. Independent reviews would be conducted to assess cost savings, and regulators would be involved in developing the scope of the task and in the assessment of the findings.
- Establishing target end points for cleanup and ensuring sitewide integration. This would involve using future land use as a tool for directing cleanup.
- Streamlining the regulatory process. The state of Washington and EPA committed to work together to divide the Hanford workload and to strive for a single regulator to make decisions on any given project. Regulators and DOE agreed to an early review of projects to ensure agreement on scope and direction. They will consider ways to avoid building costly new storage or disposal facilities and to defer construction of a waste-receiving and waste-processing facility. Regulators and DOE will jointly review regulations that apply to the management of mixed wastes. Regulators agreed to consider consolidation of documentation of overlapping regulation under a one-document approach. DOE, EPA, and the state agreed to launch a task force to examine specific regulations that apply to Hanford. DOE agreed to reduce its orders, both from headquarters and from Richland. There was agreement to consider acceptable reuse of facilities and reduce inventory of excess plant equipment and materials.

Train Wreck Along the River of Money—An Evaluation of the Hanford Cleanup was written at the request of the US Senate Committee on Energy and Natural Resources (Blush and Heitman, 1995) and focuses on the cleanup of the Hanford Nuclear Reservation in Washington state. The report presents criticisms that include the lack of regulatory balance (causing action without regard to cost or safety), compliance agreements that are more like partnerships, and lack of reasonable consideration of future land-use. The report recommends an evaluation of how DOE conducts cleanup activities, and it identifies several major changes in the overall regulatory process that are necessary to accomplish cleanup goals:

- Reform the legal and regulatory framework for cleanup.
- Resolve the question of the level of cleanup that will be required.
- Establish a negotiated level of funding based primarily on risk.
- Require DOE to undertake and maintain an integrated risk assessment as the primary basis for budgeting.
- Require DOE to produce and periodically update a long-range plan for cleanup that integrates all aspects of waste management, facility cleanup, and environmental restoration.

The US Office of Technology Assessment (OTA) report, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production* (OTA, 1991) addresses the public-health effects of contamination, policy incentives, priority-setting, and risk and health assessment regarding DOE sites. The report faults the lack of regulatory standards that do not address past releases from the waste facilities and the contamination of soils and sediments both on site and off site. It also finds DOE's authority to enforce its own standards governing off-site radiation doses to present a serious problem.

OTA believes that the prospects for cleanup during the next several decades are relatively poor, and the report recommends the following policy incentives for improving DOE cleanup:

- Increase congressional oversight of restoration to improve performance.
- Increase public access to information.
- Strengthen site-monitoring programs.
- Improve the process for assessing potential health impacts of waste, evaluate the possibility of off-site health effects, and develop health-based priorities.
- Establish a new office to direct risk, health, and dose assessments.
- Establish a new program for off-site assessments.
- Establish an independent advisory board to guide exposure assessments and evaluations.
- Encourage more public and scientific participation in setting cleanup policy.
- Establish advisory boards with technical staff.
- Establish a national board to coordinate site-specific boards.
- Require DOE and others to consult with boards before key decisions.
- Provide outside regulation of DOE radioactive-waste management.
- Establish a national commission with regulatory and enforcement authority with respect to radioactive-waste management.

A statement given before the US Senate Committee on Energy and Natural Resources on March 22, 1995, contains Thomas Grumbly's vision for DOE's Environmental Management Program. He explained, in broad terms, that good progress has been made at the Hanford facility. He also gave a general outline of possible congressional action related to waste cleanup. The regulatory aspects of those suggestions were as follows:

- Establish realistic timelines for goals.
- Limit enforceable milestones to 3-year goals. Completion of goals requiring longer periods would not be enforceable.
- Allow for all penalties for noncompliance to be used to fund further risk reduction.

- Alter Superfund to codify land-use considerations and universal standards.
- Allow site-based budgeting and a 3-year budgeting cycle.

A state taskforce report, *Environmental Obligations at Federal Facilities and an Analysis of the Environmental Management Program of the Department of Energy* (June 2, 1995), finds many problems with the relationship between DOE and states. (Authors of the report include representatives of the states of Colorado, Washington, and Ohio.) It indicates that DOE has many regulatory failings that must be corrected, including lack of direction, insufficiency of contractor oversight, poor contracting mechanisms, and overreliance on weapons contractors with little environmental experience. The report finds that many regulations create overlaps between federal agencies and the states and that DOE is often rigid in its interpretation of regulations to the point where nothing is accomplished. The interested states can be more flexible and creative in their approach to waste cleanup than federal agencies. The report's suggested remedies include allowing qualified states to oversee DOE cleanup and clarifying the role of anticipated future landuse in priority-setting. Other proposed reforms are the following

- Provide for independent audits of DOE's environmental programs.
- Simplify and clarify regulations.
- Eliminate overlaps that create redundant oversight of cleanup.
- Allow states to exercise EPA's CERCLA authority or implement their own proven cleanup programs.
- Allow states to be sole regulators of cleanup at federal facilities.
- Clarify applicability of the Atomic Energy Act to waste management.
- Consider including enforceable deliverables in CERCLA agreements if all agree.
- Eliminate need for duplicate studies and reviews before cleanup.
- Clarify roles that anticipated future land uses play in remedy selection.

The report of the Environmental and Occupational/Public Health Standards Steering Group entitled *CERCLA Reauthorization: Opportunities for Improving Remedy Selection and Resource Allocation* (October 22, 1993) focuses on the improvement of CERCLA without completely rewriting the law by examining risk assessment, land-use planning, and ARARs. (Thirteen DOE laboratory directors chartered the steering group.) The group finds that the requirement of Superfund to comply with ARARs leads to excessive costs, which in turn discourages future landuse. The group sees the following as methods of improving site remediation

- Use local authorities and citizens in the early stages of risk assessment.
- Focus on risk reduction rather than residual risk.
- Use best estimates and probability distributions of critical data in risk assessment rather than the 95th percentile.

- Take realistic land-use assumptions and projections into account.
- Remove the ''relevant and appropriate'' section of the ARARs.

The General Accounting Office (GAO) report *Federal Facilities: Agencies Slow to Define the Scope and Cost of Hazardous Waste Site Cleanups* (GAO, 1994a) suggests the following amendments to CERCLA

- Require agencies to submit plans for cleanup to EPA.
- Require agencies to report annually to EPA on progress.
- Require agencies to develop and update cost estimates.
- Require EPA to report annually to Congress on agencies' progress.

The GAO report *Nuclear Cleanup: Completion of Standards and Effectiveness of Land Use Planning Are Uncertainties* (GAO, 1994b) focuses on the idea of land-use planning as related to radioactive-waste and hazardous-waste disposal and the problem of national standards for waste sites. It indicates that comprehensive cleanup standards are needed. In addition, EPA needs to provide more detailed 5-year reviews of sites with residual contamination.

A report to Speaker Newt Gingrich by the Speaker's Task Force on Nuclear Cleanup and Tritium Production (1995) provides *The Top 20 Ways to Turbocharge DOE Cleanup*

- Delegate regulatory authority over CERCLA to the states.
- Streamline or eliminate Superfund's ARARs.
- Consider final land and resource use before selecting remedies.
- Use risk assessment and cost-benefit analysis.
- Include various RCRA reforms in Superfund reauthorization.
- Amend RCRA's definition of allowable storage.
- Have RCRA consider reform of ''mixture,'' ''derived-from,'' and ''contained-in'' rules.
- Have RCRA consider reforming the Atomic Energy Act Exclusion.
- Integrate NEPA with other state and federal actions.
- Encourage a streamlined technology-permitting process.
- Streamline enforcement of health and safety regulations at sites.
- Grant broad decision-making authority to local DOE site managers.
- Streamline and localize the DOE order process.
- Reform federal indemnification procedures.
- Expedite opening of the Waste Isolation Pilot Project.
- Eliminate statutory metric-system requirements at sites.
- Leverage federal resources by allowing long-term privatization under incentive-based contracts.
- Ensure stable but flexible budgets for cleanup sites.
- Pass legislation to streamline the procurement process.
- Include the above provisions on a test or demonstration basis at one or more sites.

Part III

Priority-Setting, Timing, and Staging

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Introduction

The Subcommittee on Priority-Setting, Timing, and Staging was established to review two areas of concern for Assistant Secretary Grumbly. The first, linked directly to priority-setting, dealt with

> the process of setting priorities for environmental management activities and how the process incorporates societal values, costs, current regulations, and risks to the environment, public health, and worker safety.

The second, focusing on the issues of timing and staging, dealt with

> how the environmental management program can schedule technology development and remediation and restoration efforts to maximize cost savings and minimize risks to the environment, public, and workers.

The two issues are closely related. When to undertake a particular activity and how best to organize its components—timing and staging—depend on the priority that the Department of Energy (DOE) attaches to completing the activity. Similarly, which activities should be undertaken first—priority—depends on the options, requirements, and advantages and disadvantages related to the timing and staging of the possible activities.

The subcommittee has concluded that priority-setting for DOE's Environmental Management Program has been problematic more for management reasons than for technical reasons. Important features that are essential for a sound priority-setting process at DOE, but that the subcommittee perceives as still lacking are the following:

- Clearly stated goals that are the fundamental end point of the priority-setting decisions.

- Stakeholder involvement in the priority-setting process that is both timely and integrated between local and national levels.
- Priority-setting that is comprehensive in scope (including intersite rankings among different geographic regions) and that goes beyond risk-ranking.

A range of organizational and cultural changes are also necessary to achieve as part of filling these gaps. Tools exist that can support most of the priority-setting needs in a technically sound manner once the management issues have been addressed, although they will need refining and adjustment to suit the specific needs. The rest of this report explains the management issues in more detail and provides some general guidance on the usefulness of different supporting tools.

Current Realities and Historical Context

The subcommittee recognizes the extreme difficulty of establishing priorities in an agency as complex as DOE. DOE has a number of missions. It has a national-defense mission, an energy-security mission, an environmental-quality mission, and a basic-research mission in support of its other missions. Moreover, DOE seeks to contribute to the nation's economic productivity by collaborating with industry wherever its established missions have provided an expertise that some industrial partner wishes to share. The programs of DOE that are undertaken in the pursuit of its missions inevitably have some goals that are inconsistent and some that are actually in conflict. In addition, DOE's priority-setting efforts will be affected by such factors as shrinking budgets; institutional relationships between DOE Headquarters, field offices, and contractors; and local and national political considerations. The subcommittee has sought to develop recommendations that will be useful and durable in the face of those disparate and changing circumstances.

DOE must and does decide what actions to take and how to spend its resources. In making its decisions and undertaking its actions, DOE is perforce establishing priorities. The subcommittee has gained, in the short time available, as much understanding as it could of the historical context and current practices for setting priorities in the DOE Office of Environmental Management (EM).

EM has its roots in a 1989 reorganization of DOE. At that time, it was apparent that the activities associated with waste management and environmental restoration were increasing in budget and complexity and that if the demands of federal and state regulators were to be met, a centralized planning process within DOE that could take into account the different situations across the entire DOE complex was needed. Before then, activities had been dictated largely by the desires of site managers, and their needs were not the principal concerns of the programmatic assistant secretaries who had responsibilities for the sites. With the creation of the Office for Environmental Restoration and Waste Management (later the Office of Environmental Management) came an attempt at more centralized planning; meanwhile DOE was continuing in its efforts to accommodate federal and state environment regulators who had only recently been given some jurisdiction over the sites.

While the 1989 reorganization was taking place, dramatic reductions occurred in the defense-related activities of DOE with the conclusion of several agreements between the former Soviet Union and the United States on reducing the number of nuclear weapons. DOE, states, and the Environmental Protection Agency (EPA) were establishing consent agreements establishing the outline of site-specific remediation efforts. It is not inconsequential that DOE has engaged in a massive environmental-remediation effort at the same time that the defense weapons complex has been declining. At some DOE sites, states and localities may see it as a high-priority matter of DOE's EM program to ''fill the gap'' with respect to employment and economic activity, whereas DOE and some taxpayers may see the expeditious, economic, and safe return of sites to the local communities as having high priority.

Another turn of events important for understanding the present context of the EM program was DOE's loss of some of its self-regulatory status in the environmental arena. Before 1980, DOE generally considered itself to be largely responsible for its own environmental performance. During the 1980's, however, state and federal environmental regulators gained partial jurisdiction over DOE sites—often in an atmosphere of distrust and hostility.

Today, many of the priorities in the EM program are set by the 100-odd compliance agreements that DOE has entered into with EPA and the states. These agreements have often become the primary ''legal'' drivers for EM budgetary decisions in DOE. Requests for funds from field sites and the later requests by DOE to the Congress for funding are driven largely by compliance with federal and state statutes and agreements.

EM developed and tested a highly sophisticated priority-setting tool for setting environmental restoration priorities called the Environmental Restoration Priority System (ERPS) from 1988 to 1991. However, the DOE discontinued the development and use of this system because of strong opposition by the states and other stakeholders who felt that the system had been developed without their input (Jenni et. al., 1995).

More recently EM established a set of 6 goals to guide its budget formulation process:

- Urgent risks and threats.

- Workplace safety.
- Managerial and financial control.
- Outcome orientation.
- Focused technology development.
- Strong partnerships with stakeholders.

The subcommittee defined its task as providing recommendations to DOE for improving its priority-setting system so that it allocates its available resources at its facilities to manage wastes, restore degraded environments, and otherwise protect the public's health and welfare in a cost-efficient and credible manner.

An Inclusive System

Priority-setting is often thought of in a limited sense, for instance, as applied to deciding which of many items on an agenda should be undertaken first or how much of an available budget should be spent. In the context of DOE, it can be used for screening activities, intra-site ranking of similar projects, intra-site ranking of projects in different areas, site-to-site ranking, etc.

To be successful, a priority-setting system[1] should be comprehensive in scope, addressing all forms of EM decisions and activities and addressing all DOE sites as a group. It must be technically sound, but it also needs to be rooted in the organization's basic visions about its purpose and goals. At the same time it is important to note that DOE does not require a sophisticated system to identify the highest-risk cases first; we recommend that DOE continue to act immediately to identify high-risk cases.

The subcommittee believes that priority-setting, timing, and staging are comprehensive planning activities that must take place within an organized and effective management context. Organization and management set the context for achieving progress in priority-setting, timing, and staging decisions. Progress in such decisions cannot be achieved simply through application of new or improved tools and analytical techniques. DOE requires a fundamental and pervasive change throughout the organization.

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[1] The subcommittee uses the term "priority-setting system" as opposed to "priority-setting process" to emphasize that we believe that priority-setting must extend in many ways throughout many aspects of the DOE organization, and cannot be limited to a specific process that functions independently of these other parts of the system. The term "system" should *not* be taken to mean a specific tool or methodology.

This is not a trivial undertaking. Indeed, EM has a particularly daunting assemblage of sometimes inconsistent and even conflicting responsibilities and activities that it needs to harmonize if it is to establish an effective and efficient priority-setting system. EM must deal with:

- A need to balance fairness against efficiency and optimization.
- Substantial differences in what is perceived to be acceptable risk for workers, the general public, and the environment.
- Missions that range from the correction of environmental releases and the prevention of releases to safeguarding nuclear materials vital to the nations defense.
- A large variety and number of sites and contractors.
- Multiple regulatory requirements in DOE, EPA, Occupational Safety and Health Administration, state, and multiple-party agreements.
- Different beliefs of affected parties regarding the goal of ultimate land use.

All government organizations have to deal with such conflicts and justify their actions and requests for funds to fulfill their responsibilities. EM, however, faces a particularly great challenge because of its poor record of environmental restoration, the extremely high costs of carrying out its responsibilities (cost estimates for the cleanup alone exceed $230 billion dollars), and the absence of yardsticks to measure progress (DOE, 1995a).

EM recognizes its problems and has made initial attempts to improve the way in which it makes and implements decisions. The recent *Report to Congress, Risks and the Risk Debate: Searching for Common Ground* (DOE, 1995d), is a step toward recognizing that funding and other constraints will preclude complete environmental restoration and preservation to everyone's satisfaction. The subcommittee did not review the report and cannot endorse its specific methodology or accuracy. Although the report and the recently adopted changes in the DOE budget process demonstrate an initial effort to resolve the conflict between limited resources and unlimited wishes, future attempts at evaluating risks in relation to budget priorities should give more consideration to the optimum utilization of quantitative techniques and of outside peer-review panels, verify the values assigned to different elements of the risk assessment, and provide stakeholders with assurance of the quality of the analyses. It will also be important to include stakeholders earlier if the process is to serve as a means of consensus-building for setting priorities (NRC, 1994a). DOE has taken a step in this direction by initiating the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) to provide independent peer review and structured interactions with stakeholders.

Although they constitute an improvement, the actions that the agency has already taken are only a start, and EM has not yet achieved a comprehensive and inclusive priority-setting system that will provide direction and guide the decisions that the agency must make in the coming years. Only when

DOE has established a more-comprehensive system will it be able to spend money wisely to manage risks to workers, the public, and the environment and to instill confidence in the public and Congress that it is doing so. Only by establishing a more-coherent system of priority-setting will DOE be able to break out of the incrementalism that characterizes its current decisions and prevents true priority-setting from taking place.

The agency needs to define what it is about in a coherent set of statements and processes that extend from the general and abstract to the specific and measurable, from defining its role to the specific steps that it will take to implement that role. It needs to define EM's mission, vision, goals, and objectives.

- *Mission*. Congress usually specifies an agency's mission in the legislation that defines its programs and activities. These are the work programs that allow the organization to achieve its vision. Are they consistent with the agency's vision? Are they consistent with one another? Do they define what the agency has to do to arrive at the state it has defined in its vision? How much flexibility does the agency have to modify these statements to make them consistent with its vision?
- *Vision*. The vision provides the agency, its staff, and the public an integrated look at the organization's future state. What does the agency want to accomplish? How does it want to view itself? How does it want the public to view it?
- *Goals*. Goals are targets for components within the mission, i.e., what the organization is trying to achieve in the short and long term. For example, is EM trying to maximize the amount of DOE land that will be available for public use? Is it trying to contain waste and contamination and restrict land use to the greatest possible extent to minimize costs? Is it going to have a comprehensive technology-development program to reduce costs of waste management and environmental restoration activities? EM must establish specific goals (both short-term and long-term) to implement a priority-setting system. After national goals have been established, sites should be allowed to develop alternatives in consultation with stakeholders and Headquarters. Sites, with strong input from local stakeholders, should relate each activity to national goals or their corresponding site-specific objectives. However, this should be done according to standard protocols, guidance, and formats developed by EM Headquarters to permit inter-site comparisons. Open reviews should be held at the local and national levels for site priority-setting. Revised priorities that result from stakeholder or EM review should be communicated to all parties.
- *Objectives*. Objectives are more-specific, short-term, and quantifiable measures of accomplishment in pursuit of the agency's goals, mission, and vision. Goals can pertain to many facilities or activities; objectives generally

pertain to single facilities or activities. Objectives provide answers to such questions as these: What parts of each installation will be cleaned up with the intent of release to public use? What types of wastes will be accepted for storage or treatment at each installation? What will be the role of repositories as part of the long-range management of risks? What backup plans are made? Where will the repositories be, and what volumes of waste will they be able to accommodate? What areas of the current complex will retain long-term access restrictions? What types of risks will be managed through long-term DOE stewardship rather than complete remediation?

The success of a priority-setting system ultimately depends upon how well it is actually *implemented*. For example, will the vision for EM be achieved by dismantling all or selected DOE production facilities? Should EM establish regional waste repositories for ultimate disposal of certain wastes? Should EM target technology-development activities for the most-costly problems or problems with no current technical solution?

Attributes of a Priority-Setting System

An effective priority-setting system has several key attributes which must be manifest both in the system's development and in its implementation. Without them, systems can be developed but will have little impact and not last long. The attributes are important for priority-setting in any organization, but they are particularly important in systems intended to influence decisions in organizations that are as complex and subject to such diverse and changing pressures as EM. Although the subcommittee observed encouraging signs in some attributes—such as stakeholder involvement, work is needed in all of the following key attributes:

- *Permanence and consistency.* The subcommittee has observed a lack of consistency in EM's efforts to state its goals. Budget documents and other official pronouncements often began (rightly) with a statement of the organization's goals, but the statement commonly differed from those in other documents issued at the same time. Such deviations and inconsistency will substantially inhibit the effectiveness of a new priority-setting system. EM is attempting to modify substantially the operations of a large, complex organization that is known more for its inertia and rigidity than for its agility. To make such a change requires consistency in statements about where the organization should be headed. The subcommittee recommends that the priority-setting system be established through a careful process that involves substantial opportunity for input from the full range of stakeholders. The subcommittee also recommends that once established, the priority-setting system be described and implemented consistently.
- *Clarity and transparency.* The entire process, its development, exposition,

and implementation, should be as clear and transparent to affected stakeholders as possible. Unfortunately, DOE has engendered a substantial legacy of suspicion and mistrust because of decades of operating secretly. It has made much progress already in reducing this mistrust. A clear, transparent priority-setting system will reinforce this trend and should encourage the early exchange of concerns to foster common conclusions.

• *Simplicity.* The simpler the priority-setting system and its tools are, the more likely it is to be followed and trusted. Although the associated methods should be scientifically defensible, they must also be understandable to affected parties. Because many of the criteria to be rated require subjective judgment and the inventories of toxic materials are incompletely defined, it is not always possible to establish scientific certainty. Hence, the system should not be so complex as to require elaborate analyses and consume an unreasonable amount of time to prepare, especially when the data to support great detail are not available. As more data become available or as the need for greater precision in estimating risks, costs, or benefits arises, then more complex analytical approaches are justified.

• *Stakeholder involvement.* The legacy of low public trust in and credibility of DOE originated in the need for secrecy in some programs and authorities assigned by Congress for self-regulation. The Secretary has taken steps to involve people affected by DOE's actions in the decision-making process. This has been successful and should be continued formally. Stakeholders do not have authority to determine funding, but they should participate in and understand the basis of funding decisions. The inclusion of state and local stakeholders in this process for FY 1997 is laudable. DOE's experience, and the experience of other organizations in similar circumstances, suggest that regulators and public stakeholders need to participate to the greatest extent feasible in priority-setting that leads to DOE budgetary decisions. (This point is similar to that made in the National Research Council's *Building Consensus* report (NRC, 1994a) with respect to DOE's use of risk assessment in its environmental remediation program.) However, public and stakeholder interest is strongly aligned with the interests of specific sites, and DOE's current mechanisms for public involvement appear to do a better job of promoting the budgetary stakes of particular sites than of facilitating intersite budgetary tradeoffs. Thus, while allowing for public participation, DOE must also fundamentally alter its budget-allocation process to allow for more-centralized setting of overall goals that promote the national interest. EM should apply the following principles related to stakeholder involvement:

—For stakeholder involvement in priority-setting to be knowing and intelligent DOE must provide stakeholders with all appropriate planning and budgeting guidance.

—Stakeholder involvement in priority-setting must occur at the installation level, the field-office level, and the Headquarters level. Therefore, DOE should tailor stakeholder involvement to specific priority-setting requirements, such as different types of stakeholder representatives and different types of stakeholder training.

—Stakeholder involvement in different EM program components—e.g., Community Leaders Network, the Military Toxics Project (a network of community groups concerned with environmental justice), Transportation External Coordinating Committee, Environmental Management Advisory Board, and State and Tribal Government Working Group (STGWG)—should be integrated into the overall priority-setting effort.

—Stakeholder involvement in priority-setting must be effective in helping EM to establish and resolve conflicts in field office and installation priorities and Headquarters priorities. Therefore, EM should annually evaluate stakeholder priority-setting efforts. The exercise should not be a one-time effort but should be an iterative process that encourages accountability of DOE field management and contractors.

Implementation of a Priority-Setting System

The most carefully conceived and well-thought-out priority-setting system will bring little improvement if it is not implemented coherently and comprehensively for all the activities that take place in the DOE EM Program.

It is often said that the primary function of priority-setting is to help an organization decide what it will **not** do. In the case of EM, for instance, three groupings of activities can be made as follows:

- Activities that provide a measurable benefit for the Program as defined on the basis of cost, risk management or risk reduction, and schedule.
- Activities that support a measurable benefit.
- Activities that do neither of those.

Activities in each of these groups are affected by different factors. The term used by EM is ''driver.'' Those activities can be classified according to their drivers, specifically:

- *Required drivers* that necessitate a particular activity, such as triparty agreements, consent orders, and the Code of Federal Regulations.
- *Voluntary drivers* that support the activities of DOE's overall mission of increased efficiency, such as infrastructure needs and risk-reduction or risk-management needs.

Table 1 and Figure 1 depict the inter-relationships and overlaps of the three groups of EM activities and their drivers. The most basic goal of EM's priority-setting system should be to distinguish those activities that have or support measurable benefits from those that are extraneous and have no cost- or risk-reduction benefits. For example, activities that are either voluntarily or driven by regulation *and* provide a measurable benefit should be maintained and evaluated further to determine their exact priority, timing, and staging. Activities that neither provide nor promote or sustain measurable benefits *and yet* are voluntarily implemented should be eliminated. Those activities that are driven by regulation or law and that are identified as having no measurable benefits or do not support or sustain other beneficial activities, should be the subject of an effort by DOE to have those regulations modified or laws amended. Twenty-three state attorneys general have expressed a willingness to renegotiate previous commitments for environmental cleanups. DOE should aggressively explore these opportunities with the goal of reaching agreements that will result in faster and greater risk reduction, lower expenditures, and implementation plans that are more in accord with scientific and budgetary realities.

RELATIONSHIP OF OTHER MANAGEMENT SYSTEMS TO PRIORITY-SETTING

More must occur than the definition of mission, vision, goals, and objectives. DOE must also build an entire management structure in which the priority-setting system must function. This management system should include the following:

TABLE 1 EM Activities

	Measurable Benefit	Supports Measurable Benefit	Neither
Drivers Required by:			
DOE Order			
Other Regulation	X	X	seek changes
Compliance Agreement			
Law			
Voluntary Drivers	X	X	cease activity

NOTE: X = Evaluate risk, cost, and benefit for priority-setting, timing, and staging.

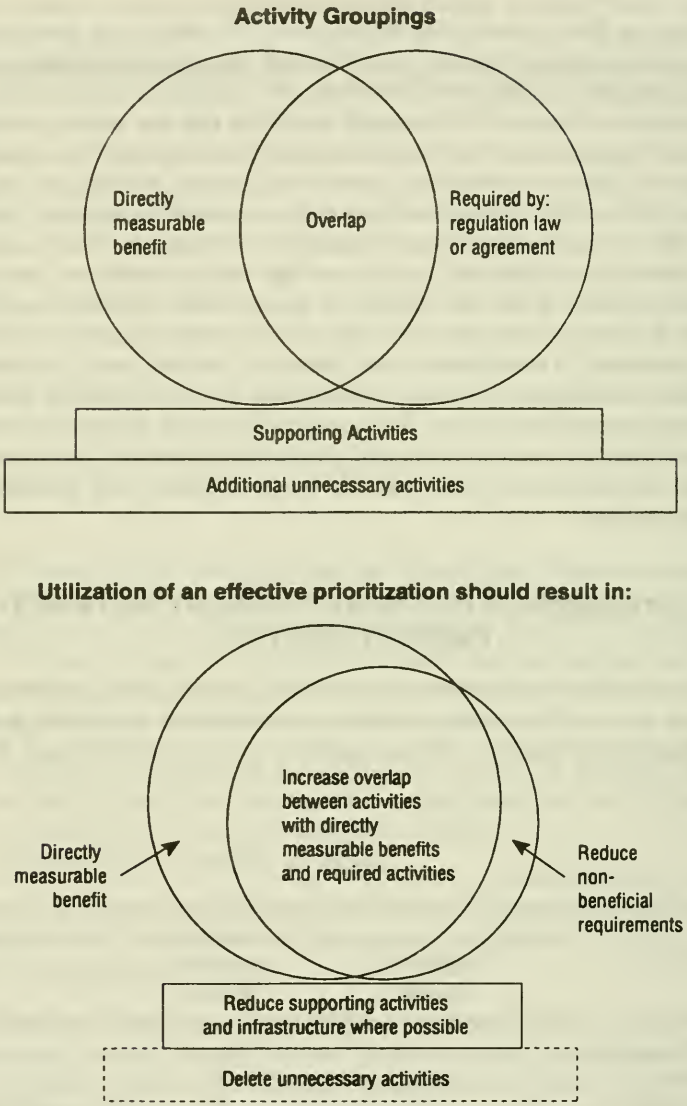
Activity Groupings
Directly measurable benefit
Overlap
Required by: regulation law or agreement
Supporting Activities
Additional unnecessary activities
Utilization of an effective prioritization should result in:
Directly measurable benefit
Increase overlap between activities with directly measurable benefits and required activities
Reduce non-beneficial requirements
Reduce supporting activities and infrastructure where possible
Delete unnecessary activities

FIGURE 1 Activity Groupings

- Annual Budget formulation system.
- Personnel system.
- Contracting system.

Each of these systems will be discussed briefly. The key features which they must have to permit the effective implementation of the priority-setting system will then be described. There are three elements which should be common among all those systems: incentives, measures of performance, and feedback mechanisms to improve performance.

INCENTIVES, METRICS, AND FEEDBACK

There are a number of institutional barriers and disincentives to the effective setting of priorities that can be readily observed, and which several workshop participants noted. These barriers must be addressed. Doing so might require changes in how EM is organized and operates. Incentives will have to be created in a way that allows centralized goals to be achieved through decentralized decisions. Accountability, using accurate measures of performance, is key to aligning progress to DOE's vision. Particular examples of disincentives are as follows:

- *Lack of accountability for progress.* The current system appears to have no clear measures of progress and does not hold project or site managers accountable for achieving the progress desired. It is important to note that all too often progress is seen as meeting the nearest point in a schedule rather than moving toward an objective in an organized and rational way. All too often the pressures to meet the schedules are so important that consideration cannot be given to innovative technology, innovative approaches to the process, or any other change that might be desirable in the big picture.
- *Self-perpetuation as a goal.* Self-perpetuation seems to be a strong, if unexpressed, goal driving the system. Progress in cleaning up is often in conflict with this goal and often appears to lose in the conflict.
- *Costs as a ''good,'' risks as an ''asset.''* Because the funding allocated to a site is often influenced by the magnitude of the risks at the site and the estimated cost of cleaning up its contamination, there is a strong incentive to overestimate both risks and costs to increase the amount of money available and the salaries, responsibility, attention, and employment that typically result from large budgets.

As already noted by DOE, fundamental values of the organization might have to be altered, and a new culture might have to be instilled so that the changed values are spread throughout the organization. For example, increasing budgets might be valued now as a sign of success, but would be antithetical to an EM program in which success were defined as continuously improving the productivity of the program. At DOE facilities, contractors and workers have a strong incentive to make work take as long as possible; it guarantees them a job, eliminates relocation problems, and so on. DOE needs to develop incentives that will strongly counter that inherent inertia. If, for instance, it wants to reduce its workforce and complete the cleanup job early, it might provide large bonuses and relocation allowances to workers who achieve those goals. It should also be noted that such changes might extend to the participating public as well and might require an adjustment of expectations regarding the public's inclusion in the DOE decision-making process.

Effective implementation of a priority-setting system and its companion management systems requires constant evaluation of how well the systems help to accomplish the vision, mission, goals, and objectives on which it is based. Without a way to evaluate that, managers will be unable to evaluate the effectiveness of the department's operations and make corrections when they begin to diverge from their goals.

Thus, it is essential that DOE's managers and contractors be required to measure what was accomplished for the funds spent and to quantify future improvements for the funds requested. The general perception in recent years has been that public funds for environmental restoration have not been well spent, but there are no concrete measures of progress to substantiate this perception. The number of facilities decontaminated or removed from a status where monitoring is necessary and the relative cost per square foot of building space are better measures than the number of reports filed with a regulatory agency. Hence, progress must be measured in such terms as reduction in a radionuclide or chemical concentration in an aquifer or the effect of preventing a release of an aerosol or effluent from a source, not in the traditional government terms of, e.g., the frequency of inspections or the number of hours of stakeholder consultation.

A very useful metric is periodic ''benchmarking'' comparison with the best of the private-sector efforts. EM should calculate the cost of common environmental-management efforts undertaken by the department and compare them with those for equivalent activities in the private sector. Examples include low-level waste disposal at Chem-Nuclear in South Carolina, Envirocare in Utah, and U.S. Ecology in Washington; mixed-waste management subject to RCRA; and use of soil covers to minimize leachate problems. Such comparisons will indicate whether spending is out of line with the private sector.

Other mechanisms might include

- A national stakeholders review panel to review results of analyses.
- Technical evaluation of the validity of the analyses by a contractor.
- Red-team or inspector general evaluations.

The final step required for a successful management system, including a priority-setting system, is a feedback mechanism that allows corrections in the system when it is deviating from the vision, mission, goals and objectives that the department has established. The effectiveness of this feedback system will depend substantially upon the accuracy and relevance of the metrics incorporated in it.

BUDGETING

In the budget process the role of Headquarters is to set general policy guidance and secure funding through Congress. The sites have the specific knowledge of those activities with the highest potential for harm, those that can be delayed in implementing remedial action, and those with the best potential for risk reduction. EM management at Headquarters understands the overall budget constraints placed on the Program. The product of the interaction between the sites and Headquarters—the budget request—should reflect their mutual understanding and the input of stakeholders.

EM's primary mechanism for implementing priority-setting across its entire program is its internal budgeting process. The priority-setting system and the budget system are interconnected, since projects and programs must be prioritized for funding. For FY 1997, under a directive of Assistant Secretary Grumbly, the program justifications of specific projects and programs were developed with reference to four priorities:

- Protection of worker and public health and safety and the environment.
- Safety, security, and stabilization of special nuclear materials.
- Compliance with federal, state, and local regulations and statutes, related enforceable compliance and cleanup agreements, and DOE orders.
- Compliance with other agreements to which DOE is a signatory (memorandum, Asst. Secretary Grumbly to Distribution, Feb. 13, 1995).

In addition, high priority was given to those investments which significantly drive down future costs as well as those that stabilize nuclear materials and facilities. This is a departure from earlier DOE priorities. At the outset of the EM Program the extent of the remediation task and its total costs were poorly understood. DOE was under attack on all fronts as being insufficiently aware of and responsive to its environmental problems. Reducing future costs was lower in priority than immediate regulatory compliance. These priorities have changed, and this change has contributed to the difficulties experienced by DOE employees and contractors.

As we understand it, FY 1997 development of the budget proceeded as follows:

- National (DOE Headquarters) direction was provided to each of DOE's site offices and apparently was focused on funding targets.
- Sites set priorities for their work and submitted them to DOE Headquarters.

- After discussions between the sites and management, the sites modified some priorities.
- A national meeting was held (involving all DOE sites and Headquarters) at which Mr. Grumbly made decisions regarding the site and Headquarters priorities.
- Those decisions were later shared with stakeholders, and stakeholder questions regarding both the process and the resulting priorities were answered.
- A "lessons learned" meeting was held to discuss the process and make appropriate changes.

These last three steps are unique to the DOE EM Program and special permission was given by the Office of Management and Budget for this new process of including stakeholders in the budget formulation process. Further modifications, intended to make the process more transparent to stakeholders, are being developed by EM for FY 1998.

One problem that the subcommittee noted in the resulting 1997 budget-formulation process is inappropriate "bundling." All priority-setting schemes rely to some extent on the assumption that the objects being compared are roughly similar. "Bundling" is the process of lumping dissimilar things into packages that are then thought of as constituting a single activity. In the case of DOE's Environmental Remediation Program, bundles of proposed remedial actions might be made up of elements that if examined individually, would be seen to pose different types of risks or to require different kinds of processing from an engineering and technical standpoint. Such bundling can erode the ability of priority-setting systems to make useful distinctions, inasmuch as the benefits of reducing the risks associated with high-risk components are offset in risk-benefit comparisons by the added costs of taking care of costly but lower-risk elements in the same package.

A variety of forces, ranging from the internal dynamics of DOE's budgeting process to DOE compliance agreements with states and federal regulators, appear to be creating this bundling problem. A prominent example of such bundling occurred in the Tank Waste Remediation System (TWRS) at Hanford. Originally, in the Hanford site's 1987 environmental-impact statement, the contents of the single- and double-shell tanks at the site were assigned to different disposition sequences. The contents of the double-shell tanks were to be retrieved, treated, and disposed of, but action on the single-shell tank contents was to be deferred (DOE, 1991). In the 1989 *Tri-Party Agreement* with the state of Washington and EPA, however, all tanks were bundled into the common retrieval, treatment, and disposal path that became TWRS. The planned TWRS retrieval and processing sequence gave rise to a single "high public safety" risk data sheet in the recent DOE document *Risks and the Risk Débate: Searching for Common Ground* (DOE, 1995b), June 1995, Appendix C, with a projected 5-year cost of nearly $400 million. Even though most double-shell tanks at Hanford probably pose much lower risk to the public than do leaking single-shell tanks and tanks on Hanford's ''watch'' list, all are treated in the same way, and all costs are counted against high-priority risk reduction in DOE's *Common Ground* document.

DOE should address such bundling problems by re-examining how disparate projects and program elements are grouped for budgeting purposes with an eye to regrouping those that pose similar risks. The subcommittee believes that that could be done by a central audit (either by Headquarters or by an external independent party) that sets a target of examining perhaps 10% of the activities listed on the risk data sheets per year. An alternative might be to set a threshold on projected cost and examine all activities above the threshold. If inappropriate bundles are identified, they should be disaggregated and reranked. DOE should also establish some process for rewarding units that bundle activities properly and penalizing units that do not. The result of such an audit, however conducted, would increase the number of activities in the budgeting process in such a way that the costs associated with individual activities would, on the average, be lower—in some cases, the subcommittee believes, by a considerable amount.

The Appendix includes one approach to budgetary priority-setting that meets these requirements and satisfies the attributes listed in the previous section.

PERSONNEL

Budgeting is only one of the elements of management that drive how the DOE operates. The personnel system is another, and it might have an even greater impact on how effectively EM implements its priority-setting system.

Government personnel systems are notoriously unresponsive, and the DOE system is notorious among government systems. Such an unresponsive system can substantially inhibit the implementation of needed changes. Staff both at Headquarters and in the field should be encouraged to develop innovative approaches to solve problems, rewarded if successful, and not penalized if unsuccessful. If the personnel system is not changed to reflect or incorporate these changes, the implementation of new priorities will be much more difficult and, unless substantial pressure is continuously applied, is likely to revert gradually back to its former shape with its former priorities.

Another subcommittee has addressed the problems associated with the current personnel system in greater detail and has made some recommendations regarding how it could be made more responsive. If that is not done and if the personnel system is not made to conform to the new priority-setting system, the implementation of the priority-setting requirements is likely to be seriously retarded.

CONTRACTING

Much of the work undertaken under the DOE's auspices is done by contractors, not employees. It is perhaps even more important to modify the contracting system than it is to modify the personnel system. The former contracting system, established primarily on a ''cost-plus'' basis, rewarded input rather than output, effort rather than accomplishment. The subcommittee recognizes that EM has begun to make some important changes in its contracting system—most notably in the Rocky Flats performance-based contracts that were recently awarded. Those are important changes, and we applaud them.

Another subcommittee has dealt in more detail with the contracting system. We point out that basing contracts only on performance rather than on effort and providing rewards to contractors for achievement are crucial to the success of the changes that EM is attempting to implement in priority-setting. To do so properly, however, requires the completion of the process of defining a vision, missions, goals, and objectives described above. Only then can the department be sure that the performance measures incorporated in the contracts accurately reflect and incorporate the goals of the department.

Criteria for Setting Priorities

Perhaps the most important step in establishing an effective priority-setting system is identifying, defining, and selecting priority-setting criteria. It is rarely an easy task, particularly in an organization as complex and with as many divergent goals as EM. The subcommittee recommends that the DOE undertake the identification, definition, and selection carefully and deliberately, with substantial input from all the stakeholders who have to accept the final process if it is to succeed.

The first step should be to identify the full list of factors that should be taken into account in setting priorities. We suggest that the DOE consider developing and utilizing the full list of factors through a ''bottom-up'' approach. That is, stakeholders at the individual facilities would be asked to review an initial list of criteria developed by EM and recommend modifications or additions to it. A good starting place for developing this list would be the extensive list of evaluation criteria developed for and incorporated into the ERPS model (see Figure 2). The reviews and suggestions would be aggregated through the field offices and combined at Headquarters. A process of consolidation and redefinition would follow. The goal of this process would be to derive a manageable set of priority factors that are inclusive and clearly defined so that they are interpreted consistently by everyone involved in the EM priority-setting system, from Headquarters staff to local advisory panels and other stakeholders.

To ensure that the process is comprehensive and the criteria clear, the DOE might want to consider involving any of the following groups in the winnowing and defining:

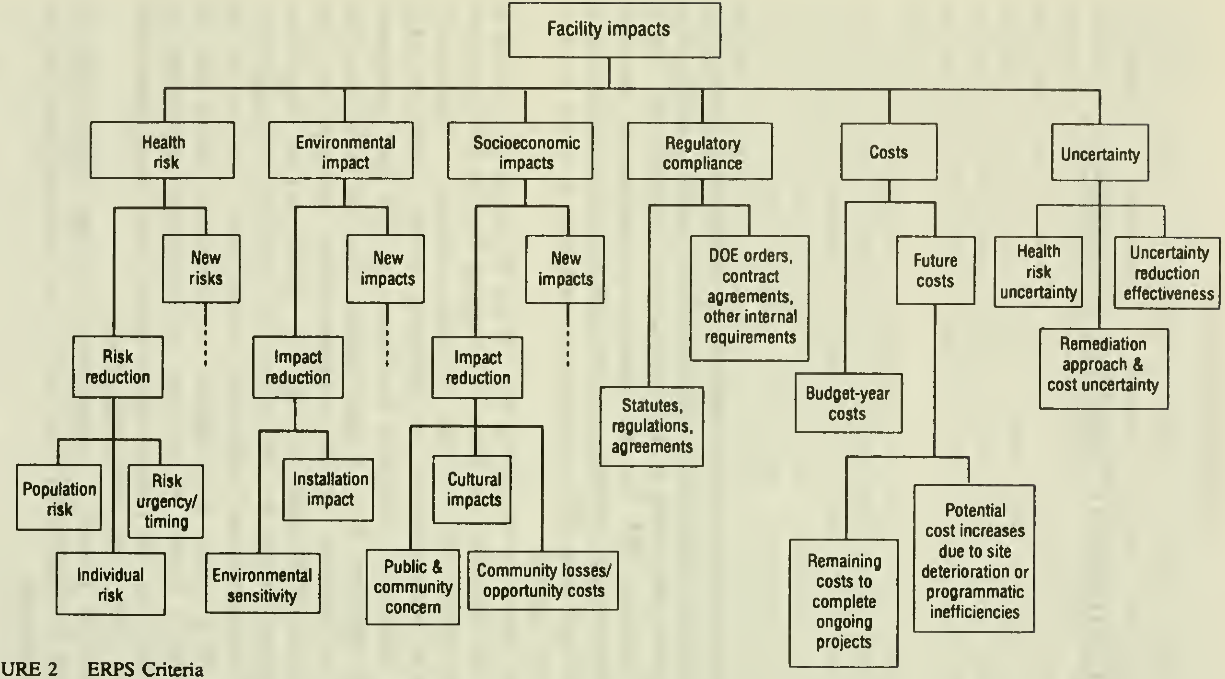
Facility impacts
Health risk
Environmental impact
Socioeconomic impacts
Regulatory compliance
Costs
Uncertainty
New risks
Risk reduction
Population risk
Risk urgency/ timing
Individual risk
New impacts
Impact reduction
Installation impact
Environmental sensitivity
New impacts
Impact reduction
Cultural impacts
Public & community concern
Community losses/ opportunity costs
DOE orders, contract agreements, other internal requirements
Statutes, regulations, agreements
Future costs
Budget-year costs
Remaining costs to complete ongoing projects
Potential cost increases due to site deterioration or programmatic inefficiencies
Health risk uncertainty
Uncertainty reduction effectiveness
Remediation approach & cost uncertainty

FIGURE 2 ERPS Criteria

SOURCE: Lee Merkhofer, Applied Decision Analysis, Inc. Presentation at the National Academy of Sciences, June 27, 1995.

NOTE: Dashed lines below "New risks" and "New impacts" indicate subobjective structures similar to those under "Risk reduction' or impact seduction," respectively.

- A national stakeholders panel.
- Focus groups, which can identify issues that need to be considered in the priority-setting system.
- Site-specific stakeholder advisory groups, which can help to ensure that site-specific considerations are duly integrated into a more centralized system of priority-setting.
- Technical review panels, which can assess the adequacy of information being generated and help to identify analytic or information gaps and shortcomings.

Although it is important to identify and define the full set of relevant criteria, the actual process of establishing priorities is likely to be driven by only one to three of them, and the department must get agreement on which, from the full list, are the most-important priority-setting factors. That should be done at the Headquarters level with the full involvement of the Assistant Secretary and Secretary.

The primary factors should demonstrate two characteristics: they can be quantified on a scale that allows activities to be ranked from most important to least important, and the factor metric, i.e., the means of estimating the extent to which each activity satisfies these factors, is determined consistently for all the activities. The value placed on the primary-factor metrics must be independent of where an activity would occur and free of any rater biases.

Two criteria that are now treated as primary factors and that would probably retain this pre-eminence in any priority-setting system are risk and regulatory considerations.

USING RISK

Some measure of risk or risk reduction associated with an activity is likely to be and should be a primary factor. Examples of possible primary factors related to risk are the risks that would exist were the activity not undertaken, the reduction in risk that would result from undertaking the activity, and the risk reduction per dollar of expenditure that would be associated with undertaking the activity.

The subcommittee recommends that, to the extent possible, a single set of general methodological guidelines for risk assessment be applied to all sites and proposed activities. We recognize that establishing such a set of guidelines may be difficult. Currently, there is no consistent methodology for assessing risks at DOE sites (NRC, 1994a). Unfortunately, some of these inconsistencies are imposed on the DOE by different regulatory agencies demanding different degrees of rigor in risk assessments (NRC, 1994a). However, without some consistency in conducting risk assessments, it will be very difficult to set priorities coherently.

Risk assessment methodology need not depend upon sophisticated quantitative models and analytical techniques. Indeed, it is appropriate that the degree of complexity of risk assessments varies from site to site depending on the amount of data available and the purpose for which the risk assessment is being done. The view that a risk assessment process is absolutely essential for dealing effectively with the risks at DOE facilities must be tempered by the need to draw from existing data, which sometimes cannot support an exhaustive risk assessment (NRC, 1994a). In the early stages of priority-setting, a simpler, less quantitative risk assessment may be sufficient for managers to make preliminary decisions as to whether further assessment is necessary. The subcommittee believes that using these screening-level (possibly judgmental or qualitative) risk assessments is possible. As appropriate (i.e., where it is essential for the decision-maker and where sufficient data exist), more quantitative analyses should be utilized. EM should not be deterred from making priority-setting decisions where there are limitations in data and knowledge. These limitations should be noted explicitly as EM pursues its obligation to make decisions. A note of caution in the use of screening-level risk assessments: because they are often quite conservative and may overstate risk, their use is most appropriate for decisions about whether there is no any potential for significant risk or whether more analysis is needed.

Future land-use assumptions can have a profound effect on the estimation of risk. Sites that will be occupied in the future pose many more exposure opportunities than sites that will be left uninhabited. Local stakeholders must have a significant voice in decisions about future land-use. However, EM must ensure that these decisions are reasonable and that the exposure assumptions associated with the selected land-uses assumptions are consistent across sites and facilities sharing the same future land-use scenario. One might also wish to present the range in the risks by assuming perpetual isolation and unrestricted residential use, in addition to each site's selected land-use scenario.

Socioeconomic factors affecting stakeholder groups and Indian tribes may also be important to incorporate in risk assessments. A key to the successful identification and treatment of these factors is the early involvement of the interested parties in these efforts (NRC, 1994a).

Tools

In this section, we describe the range of types of priority-setting tools that might be considered for adoption as part of a re-engineered DOE and EM budget allocation process. This is kept brief, and is intended only to highlight the range of acceptable approaches that may be useful. An earlier NRC committee report, *Ranking Hazardous Waste Sites For Remedial Action* (NRC, 1994b) provides a synopsis of the qualities of good tools, and reviews of three specific existing tools that could be of relevance here. Rather than repeat such discussion, a section of that report describing the characteristics of a good priority-setting tool is reproduced as an appendix to this subcommittee's report.

Use of any tools in a priority-setting system should have the same attributes identified earlier in this report as desirable for the entire system, such as providing substantial opportunity for input from stakeholders on their values and concerns and input from technical experts on complex technical issues. Priority-setting tools generate alternatives for action and evaluate alternatives and combinations of alternatives against clearly articulated, consciously weighted decision criteria.

The main concern in selecting a tool is that the content be aligned with and supportive of an institution's goals. Choosing the right tool to support a priority-setting system involves some balancing. Tools that are attractive on process grounds might not necessarily lead to good outcomes. Formal, mathematical tools that are easy to use and understand might fail to embody sound decision logic or, in their reliance on subjective judgments, lead to results that are unstable in the face of small changes in the circumstances under which they are applied. The DOE needs to consider these and other process-related characteristics as it develops or selects tools to support its priority-setting system.

In all cases, it is important to emphasize that the output of decision-aiding tools should not be the end points of the priority-setting system. Once specific options or strategies have been identified, analyzed, and assessed, decisions must still be made by accountable decision-makers regarding which options to take, and appropriate institutional and procedural enabling actions must still be taken.

The subcommittee is of the opinion that many tools that meet the DOE's needs for effective priority-setting are already available. As emphasized above, the greater barriers to more effective priority-setting are in creating an organization that allows difficult decisions to be confronted and tradeoffs to be made. Once those organizational issues have been addressed, existing priority-setting tools and approaches should provide many useful options consistent with the types of decisions that need to be made. We do not feel that trying to develop new tools would add significant value. Any system-development efforts should be targeted to improving the credibility and usefulness of tools already available in the field, either by addressing specific technical issues that have been identified in the tools or by tailoring existing systems to the goals of the DOE-EM process.

There is an important distinction to keep in mind between tools that support site-ranking and tools that support actual priority-setting. Site-ranking can place a number of risky situations in an order of risk, but such ranking does not indicate how to allocate dollars to a range of possible cleanup activities. Priority-setting, by contrast, may involve consideration of many other criteria, such as costs and incremental risk reduction. Site-ranking considering only risk can be useful for setting priorities for site assessment but not be efficient or effective for setting priorities for cleanup activities themselves. Site-ranking tools can range from strictly qualitative check-list approaches, through such scoring systems as EPA's Hazard Ranking System (HRS), to quantitative risk-assessment tools.

True priority-setting techniques, in contrast, provide enough information to assess whether to take action and what types of action to take. They are able to assist in identifying reasonable tradeoffs across sites and across activities. Thus, priority-setting tools require:

- Activity-specific information.
- Incremental information (e.g., how much change in risk is associated with an action).
- Explicit recognition of the multiple goals that an institution is trying to address.

A priority-setting system can be qualitative or quantitative. One concern with the usual quantitative approaches is that they are "black boxes" and that the fundamental nature of differences among alternatives is lost when all the decision criteria are collapsed into a single numeraire, such as utils or dollars. (Thus, they are weak in transparency and to some extent in the clarity with which facts are distinguished from values from the observer's perspective.) It is not necessary, however, to address the multicriteria tradeoffs required in priority-setting through strictly quantitative techniques, such as Multi-Attribute Utility Analysis (MAU). All that is required of a priority-setting tool is that it explicitly recognize the nature of tradeoffs inherent in specific choices of actions. Alternative multicriteria approaches that avoid focusing on a single score or value estimate might also be useful.

The drawback of such approaches is that information about multiple criteria can be voluminous and difficult for decision-makers to assimilate if not summarized into comparable (unimetric) units. It is possible, however, to devise visual displays in a variety of formats that assist interested parties and decision-makers in mentally processing and understanding the tradeoffs embodied in multicriteria information. Such approaches avoid the step of having the system produce specific rankings, or "recommended" actions; they leave such conclusions to be drawn by each person viewing the results, but they provide the basis for justifying one's own conclusions.

In addition to greater transparency, nonaggregating multicriteria approaches have the advantage of using neither a single person's preferences nor a highly uncertain representation of societal preferences, so they avoid potential concerns with bias. Nonaggregating approaches also allow exploration of alternative viewpoints in a format that is more conducive to consensus-building: the process helps people to visualize the perspective that other interested parties have with respect to a particular choice.[2]

At the site and facility levels, a number of formal priority-setting tools appear to be in use for setting budget and other priorities. One example is the Laboratory Integration and Prioritization System (LIPS), which is a multiattribute utility-based approach that was developed at Los Alamos National Laboratory and used in demonstration applications at a number of DOE sites (B. Anderson at the subcommittee's workshop of June 26–27, 1995). The subcommittee did not review LIPS and cannot provide an overall evaluation, but we believe that LIPS should be carefully considered for its alignment with DOE's goals, once DOE's overall priority-setting system is more effectively structured. LIPS might not be readily applied to the *intersite* priority-setting step, but it can readily be used for priority-setting among the many activities possible at a given location. An intersite priority-setting tool could then be applied with such site inputs as LIPS might be able to produce.

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[2] An example of such an approach is EPA's multicriteria decision-support system developed for setting priorities among strategies for adapting to global climate change, called the Adaptation Strategy Evaluator. EPA's experience in initial applications of this approach is that it is particularly useful for identifying strategic directions without the detailed analysis required of CBA, for gaining insight into why some strategies appear to meet goals better than others, and for building consensus.

ERPS is a detailed application of the MAU approach that is tailored explicitly to deal with the many unique features of DOE's EM organization in the process of allocating budgets *among sites*. Although questions have been raised on particular technical points, its main limitations are that it had poor stakeholder involvement during its development and depends excessively on judgments made by the model builders rather than reflecting widespread stakeholder consensus; it is perhaps too ambitious in attempting to incorporate all values, no matter how subjective and qualitative, into a single quantitative metric; and, as a result it failed to meet the objectives of clarity, transparency, and simplicity.

This subcommittee has not reviewed ERPS in detail and so cannot make any comprehensive evaluation of it. Nevertheless, it stands as a major contribution toward an MAU-based priority-setting tool. It is unlikely that any other MAU-based tool would substantially improve on the foundations that exist in ERPS, and we recommend that the DOE allocate tool-development resources to improving the usefulness of ERPS rather than trying to develop a new MAU model to replace it. Improvement of a system that has already been heavily funded is generally more appropriate than starting from the beginning on a new system.

It must be recognized that the budget-allocation process that DOE faces is extremely complex, and MAU-type analyses, which combine all ranking criteria according to a system of weights, will probably be essential for obtaining a systemwide sense of priorities. However, DOE might wish to consider using techniques that keep individual priority-setting factors separate in conjunction with those that merge priority-setting factors. In this way DOE can focus on generic priority-setting issues, such as technology development versus immediate cleanup, and also provide better communication and interaction with interested parties as DOE goes through its priority-setting system.

Conclusions

Establishing a robust priority-setting system for an organization as diverse and complex as EM is clearly not a simple task. The subcommittee has focused more on the attributes and characteristics of an effective priority-setting system than on the specific tools or criteria that it might employ. The organizational environment in which such a system is established and implemented may well be as important as the system itself. This organizational environment will probably be more important than the specific tools or criteria the system employs, and it will also help to determine whether the system satisfies the attributes of permanency, consistency, clarity, transparency, simplicity, and stakeholder involvement that the subcommittee recommends.

An effective priority-setting system is more than just a process of making budget decisions. It needs to incorporate specific goals and objectives so that progress can be measured. It needs to include metrics for measuring how much progress is truly being made towards accomplishing these goals and objectives. It needs to incorporate feedback mechanisms that will stimulate corrections in the decision-making process if the metrics demonstrate inadequate progress. It needs to be reflected in all of the personnel, contracting, and other administrative and decision-making processes in EM, not just in the budget process. It must be accompanied by a clear series of incentives and disincentives that reflect goals and reinforce the system. It needs to demonstrate that decisions in all these areas, both within DOE sites and across sites, are being made consistently.

Again, establishing such a system is not a simple task. It will require substantial effort and input by Headquarters and site personnel, technical experts, regulators at the state and federal level, elected officials, the general public, and other stakeholders. The subcommittee believes, however, that this is an investment that should be made. The decisions EM is making will affect the allocation of tens of billions of dollars, determine how significant human health and environmental risks are addressed, affect the jobs of hundreds of thousands of workers, determine the future use of millions of acres of land, affect local and regional economies throughout the nation, and have an impact on national and international security. Clearly, these are decisions that need to be made carefully and correctly. Clearly, the investment is worth it.

The subcommittee does not want to suggest that all decision-making be put on hold until this investment is completed. Decisions must be and will be made regardless of whether an adequate priority-setting system exists. Certainly the DOE has some potentially high-risk situations that it must address. It does not require a sophisticated system to address these worst cases first, and we recommend that it do so. We also recommend that, in the interim, EM postpone those actions that do not significantly reduce risks or save money, and that are not required by current laws. Even when there appear to be current legal requirements, if the action is not addressing a significant risk, we recommend that the agency ''push back'' on the regulatory drivers. Ultimately, in this period of tight federal budgets, everyone will benefit if the agency can demonstrate that it is efficiently spending its resources on the most serious problems.

In short, there is plenty to do and there is a need to do it right. We believe that EM has taken some useful first steps, but it has many more to go.

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Appendix
ONE APPROACH

During the subcommittee's deliberations, one member was tasked with developing an approach to priority-setting that would incorporate the various characteristics and attributes that the subcommittee believed were important. This appendix contains the result of that effort.

The proposal stimulated some controversy. Some subcommittee members thought it was a useful contribution which would clearly improve the budget formulation and other priority-setting processes. Other members and reviewers considered it naive, academic, infeasible, and bureaucratic. Because of time constraints, the subcommittee was unable to perfect the proposal in response to these comments.

Thus the original proposal is included in this appendix, without the subcommittee's modification or endorsement, in the belief that it may contain some concepts that would be of interest and value to the Department.

The proposed framework builds upon the existing budgeting process and incorporates substantial involvement at the local level although leaving the decision-making ultimately at the national level. The framework begins with the clear articulation of DOE's priorities for EM expenditures and, proceeding through a nine-step process, finally gives some leeway to the local stakeholders to make a final choice about the priorities which best suit them.

Define Priorities: The proposed process would begin with EM, with substantial input from its various stakeholders, identifying the full list of factors that should be taken into account in setting priorities.

We suggest that DOE consider developing the full list of factors through a ''bottom-up'' approach. In such a process, the stakeholders at the individual facilities would be asked to review an initial list of factors and recommend modifications or additions to it.

These reviews and suggestions would be aggregated through the regional offices and combined at Headquarters. They would then undergo a process of consolidation and redefinition.

The goal of this process would be to come up with a manageable set of priority factors which are inclusive and clearly defined so that they are interpreted consistently by everyone involved in the EM priority-setting system, from Headquarters staff to local advisory panels and other stakeholders. DOE might want to consider involving a national stakeholders panel in this winnowing and definition process to ensure that the criteria of inclusiveness and clarity are met.

Select Primary Factor: The second step would be for DOE to select from among this list what it considers to be the most important priority-setting factor. This should be done at the Headquarters level with the full involvement of the Assistant Secretary and Secretary.

The primary factor would most likely be related to the risk associated with an activity. Examples of possible primary factors related to risk would be the risk that would exist were the activity undertaken, the reduction in risk that would result from undertaking the activity, or the risk reduction per dollar spent that would be associated with undertaking the activity.

It is important that the primary factor demonstrate two characteristics. One is that it can be quantified on a scale that allows activities to be ranked from most important to least important. The second is that the factor metric, i.e., the means of estimating the extent to which each activity satisfies this factor, be determined consistently across all of the activities. The value placed on the primary factor metric must be independent of where the activity would occur and free of any biases that the rater might have. Assuming that risk or risk reduction is a component of the primary factor, this second criterion suggests the advantage of having risk assessments carried out by a neutral third party.

Appoint Trustees for Other Factors: The third step would be to designate trustees to represent each of the other priority-setting factors. These trustees should be Headquarters employees, probably assigned to the budget office. Their responsibility would be to help EM achieve the best possible priority-setting result by ensuring that the issue for which they are the trustee is given adequate consideration in this process.

Their primary loyalty must be to the DOE, not to the issue. Their goal should be to ensure that EM's budget and other priority-setting systems reflect rational, efficient, and equitable weighing of all of the DOE's priorities. Their responsibility would be to see that their factor is given due consideration.

This does not mean maximum consideration. They should not operate as representatives of particular interests who try to maximize the resources dedicated to these interests. They should operate as trustees of these interests who ensure that the interests are given fair and adequate consideration.

This is a subtle but important distinction. It is to clarify their role as trustees rather than representatives that argue for them being employed in the Headquarters budget office. Another mechanism for discouraging them from taking on a representational rather then a trustee role would be to periodically reassign factors among the trustees.

To fulfill their responsibility they should learn as much as possible about why local stakeholders may have ranked various activities as very important according to their factor. In many cases this importance would be communicated to them by the stakeholders most concerned about this factor. If this communication does not occur naturally, the trustee would have a responsibility to obtain such information by talking to the local interests after reviewing the activity summary sheets described below.

Activity Summary Sheets: The budgeting or other priority-setting system should be based upon activity summary sheets similar to those DOE is apparently using at present. The summary sheets should include a terse description of the activity and a rating of the importance of the activity with respect to each of the priority-setting factors. To the extent possible, the rating for the primary factor should be quantitative on a cardinal scale. The ratings for the other factors would also benefit from reasonable quantification, but a qualitative indication of relative importance would suffice as well.

The development of these summary sheets should begin at the local level and be fully informed by review and contributions of local advisory panels and other stakeholder input. There may be a need to modify the ratings as the summary sheets are reviewed at the regional and national level in order to improve their commensurability, but the reasons for such modifications should be indicated and be part of the public record.

These summary sheets would provide the basis for, and a public record of, the priority-setting system.

Initial Ranking: The activities would be initially ranked, from most important to least important, according to the primary factor. If the evaluation of this factor across activities has met the criteria of objectivity and consistency, this initial ranking would be a straightforward tabulation of the information on the summary sheets.

The results of this initial ranking would then be distributed to the trustees and possibly throughout the system including the local stakeholder groups, in preparation of the re-ranking process.

Re-Ranking: During the re-ranking process the trustees would argue for activities to be raised or lowered in the ranking because of the importance of the factor for which they are the trustee.

For example, the trustee representing cultural values might argue for a particular activity to be raised in the ranking because of the extent to which this activity would satisfy a strong tribal, cultural, or spiritual value in spite of the activity's relatively low impact on human health risks.

The trustee representing the cost reduction priority might argue that certain activities be lowered in the ranking because they address risks that would be attenuated naturally if nothing were done. A containment and wait strategy might result in significant cost savings in such a case over the long run.

The trustee representing compliance requirements, on the other hand, might argue that the same activity be raised in the ranking because it is explicitly identified in a tri-party agreement, and failing to undertake this activity could result in a strong enforcement action by the applicable regulatory agency.

The trustee representing EM's innovative technology priority might argue that a particular innovative technology activity be raised in the ranking and several clean up activities be lowered, because the innovative technology activity promises to achieve significant cost savings in these types of cleanups in the future. If such a re-ranking were agreed upon, the individuals responsible for those cleanup activities would have an incentive to ensure that the technology development activity achieved that goal.

To the extent possible, re-ranking decisions would be made by a consensus of the trustees and the individual responsible for presenting the ranking to the Assistant Secretary (usually the budget director). Where consensus is not reached, the disagreement would be noted for final resolution by the Assistant Secretary.

In order to satisfy the objective of transparency, the reasons for any re-ranking decisions should be made explicit, written down on the activity summary sheet, and made part of the public record of the priority-setting exercise.

Proposed Final Ranking: The proposed final ranking would be presented to the Assistant Secretary along with a summary of the disputes that could not be resolved by the re-ranking committee. If there were an unreasonably large number of unresolved disputes, each of the trustees might be limited to identifying one or two disputes that the particular trustee wanted raised to the Assistant Secretary's level. The ranking would not be changed for those disputes that were not raised.

If a large number of disputes resulted from disagreement among the trustees about the relative importance that should be accorded particular priority factors, this question should be raised to the Assistant Secretary for guidance before the re-ranking is completed. The goal would be to have only the most important issues raised to the Assistant Secretary's level.

Final Ranking: The Assistant Secretary would make decisions regarding the disputes raised to his or her level to create EM's final ranking.

Depending upon the priority-setting system that is being undertaken, EM's final ranking will usually undergo further reviews and modifications before it becomes truly final. Depending upon the rules that the DOE, the Office of Management and Budget, or others might have imposed upon this process, it may not be possible to make the final EM ranking or subsequent modifications public.

Nevertheless, at some point there will be a final ''ranking'' of some sort which will be public. In the case of the budget, the form of this final ranking will be a list of those activities which are included in the budget. The more public this process is, the more it will satisfy the criteria of transparency and credibility that are important for a priority-setting system.

A Possible Final Local Review: The process described has substantial local involvement in defining and rating the importance of the activities. However, the ranking and re-ranking are carried out, albeit informed by this local information and assessment, predominately at the national level.

The DOE may, if it is allowed to do so, want to provide the local level with a final opportunity to modify the ranking. This could be done by allowing the local site-specific advisory group to propose the substitution of a local activity that is below the cutoff line (e.g., unfunded in the budget) for another local activity of equivalent cost that is above the cutoff line. The presumption would be that such a substitution would be allowed as long as it was not unreasonably inconsistent with national priorities, particularly the primary priority factor.

Part IV

Utilization of Science, Engineering, and Technology

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Introduction

This is the report of the Subcommittee on the Utilization of Science, Engineering, and Technology. Biographical information on the members is provided in Appendix B. This subcommittee examined how the Office of Environmental Management's (EM) technology-development efforts could best utilize science, engineering, and knowledge of the health consequences of contaminated Department of Energy sites.

The subcommittee met on July 11–14, 1995. In a workshop format, the subcommittee heard presentations from representatives of Department headquarters, Department sites, contractors at Department sites, Environmental Protection Agency (EPA) headquarters, citizen groups, environmental advocacy groups, and industries engaged in large environmental remediation efforts. The workshop agenda and list of participants are included in Appendixes B and D, respectively.

A roundtable discussion was held after the formal presentations to explore some of the relevant issues. The participants identified what they considered to be the most important matters that need to be addressed, and the subcommittee used the results of the roundtable discussion and contents of the presentations, as well as the experience of the participants, to develop a framework for this report.

ENVIRONMENTAL PROBLEMS FACING THE DEPARTMENT OF ENERGY

US involvement in the nuclear arms race for 50 years resulted in the development of a vast research, production, and testing network that has come to be known as the nuclear weapons complex. Over $300 billion (in 1995 dollars) has been invested in the activities of this complex. Today, the Department is faced with the largest environmental remediation task in the federal government. Remediation will entail radiation hazards, vast volumes of contaminated water and soil, and over 7,000 contaminated structures (DOE, 1995a). DOE must characterize, treat, and dispose of hazardous and radioactive wastes that have been accumulating for some 50 years at 120 sites in 36 states and territories. Over the last 5 years, the Department has spent more than $25 billion in identifying, characterizing, and managing its waste and in assessing the nature of the remediation necessary for its sites and facilities. The Department estimates that remediation could cost a total of $200–350 billion and take 75 years to complete (DOE, 1995b). This does not include the cost of cleaning most contaminated ground waters or currently active facilities.

EM is also responsible for conducting waste minimization and pollution prevention for all of the Department of Energy. The variety and volume of the Department's activities make that effort a challenge in its own right. The Department has nearly 30 laboratories that employ about 50,000 people who are engaged in the full spectrum of scientific and engineering disciplines. Moreover, the Department is engaged in the largest weapons-dismantlement effort in its history. Those activities and current remediation efforts are subject to an effort announced by Secretary O'Leary to reduce the amount of toxic waste that the Department's facilities produce by 50% by 1999 (DOE, 1995c).

PROBLEMS IN CORRECTING THE LEGACY

EM was established in 1989 to deal with the environmental legacy of the nuclear arms race. The EM Program has six goals:

- To eliminate and manage urgent risks in the system.
- To emphasize health and safety for workers and the public.
- To establish a system that is managerially and financially in control.
- To demonstrate tangible results.
- To focus technology development on identifying and overcoming obstacles to progress.
- To establish a stronger partnership between the Department and its stakeholders.

The Department's historical culture of secrecy and its contamination problems at nuclear weapons sites have profoundly affected public attitudes and opinions. Citizens have expressed concern at the community and national levels about both the potential health and environmental impacts of conditions within the DOE complex, urging that sites be cleaned up. Technology to characterize and remediate contaminated soil or water or to treat, store, and dispose of accumulated waste safely is not necessarily available. Waste-disposal standards and cleanup goals for the environment have not been developed, agreed to, or applied at each site (EPA, 1995; OTA, 1991).

Technology development is one element of the EM Program. It includes research and development of new environmental technologies whose use is intended to make Department operations and remediation ''better, faster, cheaper, safer, and in compliance with existing regulatory requirements'' (DOE, 1995c). EM has estimated that technology development could save 10–22% in costs of remediation, treatment, and disposal, depending on the amount of cleanup performed (DOE, 1995b), and EM's Office of Technology Development estimates a savings of at least $10 billion. For fiscal year 1995, technology development accounted for 6.5% of the Department's EM budget (waste management and treatment and facility stabilization and decommissioning accounted for 66.0%, and environmental restoration accounted for 27.5%).

Findings and Recommendations

This section provides a summary of the findings and recommendations that the subcommittee came to during its deliberations. The first subsection contains general observations about the Environmental Management Program and sets the context for the specifics regarding the use of science, engineering, and technology in the program.

GENERAL GUIDANCE

- We recommend a life-cycle approach in which environmental consideration is given to all processes and products, with a goal of eliminating or drastically reducing waste streams at every stage of the activity. This should apply to both mission activities of the Department and all elements of the Department's environmental remediation efforts, which consist essentially of site characterization, remediation, waste management, and waste disposal. Implementation will require the creation of incentives and the removal of disincentives. For example, programmatic groups within the Department should use their own operational funds to pay EM for the management and disposal of the wastes that they generate, rather than use the current system whereby EM provides the service and the funding. That would provide a definite incentive for programmatic groups to minimize waste and to use appropriate technology.
- Goals specific enough to be used for decision-making (which incorporates such tools as risk-based and cost-benefit analysis) should be established for remediation. The goals should be developed with stakeholder input. They

should provide clear end points for risk-based cleanup for various land-use options, levels of long-term maintenance and monitoring, and schedules for accomplishing tasks based on difficulty. These goals should be set first at the national level with a clearly identified process that can be used to develop site-specific goals that will be within the limits of the national goals.

- Without knowledge of proposed land use and cleanup levels, the identification and implementation of appropriate technology for remediation is not possible. The emphasis that the Department has placed on these goals for future land-use plans and cleanup levels with stakeholder input is commendable. Although there is more to be done in this regard, failure to resolve these points completely should not be a barrier to continuing remediation activity. A possible way to overcome this barrier until these land-use and cleanup level goals are established is to use existing models, such as the Multimedia Environmental Pollutants Assessment System (MEPAS) and Argonne National Laboratory's RESRAD, to estimate the risks associated with the present system, the technology that will reduce the risks, and the cost to reach a socially acceptable solution.
- Planning and technology development must be iterative to take into account changing conditions and new developments in the light of the expectation that the remediation process will continue for at least 75 years and that needs and funding will change. That expectation should not be interpreted as a mandate for inaction.
- EM has vastly improved the working relationship between its site managers and stakeholders in the surrounding communities. It could make further progress by establishing incentives for Department officials and communities to make planning decisions that would result in more cost-effective and timely actions.
- Site actions must be consistent with state and federal laws; with compliance agreements among the Department of Energy, Environmental Protection Agency, and the states; with the wishes of citizen advisory groups; and with resource limitations. Guidelines and limitations can be in conflict with each other or be unrealistic. The system has become overconstrained. To achieve consistency, the Department should attempt, as industry does, to take advantage of flexibility in laws and compliance agreements. However, industry does not have as many constraints as the Department (e.g., in the form of site-specific advisory boards and compliance agreements), and for the Department, relief might require legislation.
- The Department should manage its contractors by focusing on seeing that the outcomes desired are reached (i.e., performance goals). It should not manage the day-to-day activities performed by contractors in reaching those goals.
- The Department has taken preliminary steps in the creation of a Department-wide uniform process to evaluate risks to the environment and to health

with the publication of *Risks and the Risk Debate: Searching for Common Ground* (DOE, 1995d). The subcommittee did not review the report and cannot endorse its specific methodology or accuracy. Ultimately, the process should be able to identify the locations and situations across all DOE sites that pose the most serious imminent risks to the public, to workers at Department sites, and to the environment. Imminent risks to the environment and to public and worker health should have the highest priority for action. For nonimminent risks, risk assessment should be used to identify the benefits of risk reduction as part of overall cost-benefit analyses, which should form the basis for further priority-setting and for the timely resolution of contamination problems that must be addressed as required by law or compliance agreements.

TECHNOLOGY SELECTION AND DEVELOPMENT

- An explicit, comprehensive approach is needed to identify technology needs, select candidate technologies, and pursue their development. A key to the success of this process is that it be intimately linked with identified customer needs (i.e., site-specific application) and that it use quantitative tools, such as risk assessment and cost-benefit analysis. The process of technology selection must be iterative so that technologies under development reflect recent advances. The Department has made substantial efforts toward establishing such a comprehensive approach by the establishment of its focus areas for technology development. We support the further refinement of this framework and its decision-making processes. The Department should be vigilant in ensuring programwide and facilitywide implementation of this approach.
- The Department must dramatically improve its research and technology development outreach. That can be accomplished only by opening the Department's research and development program to all qualified individuals and organizations regardless of type or location. Concomitantly with the opening of the EM R&D procurement system, a broad-based system of external peer review must be carefully implemented and monitored to ensure that the best proposals are selected.
- Technology selection should incorporate a knowledgeable independent review group that has no vested interests in the outcome and that includes people from outside the Department who work in the commercial use of technologies.
- At the time of selection and throughout technology development, care should be taken that the products of technology development can be modified for similar applications throughout the Department complex. To the extent that technologies under development have the potential for use at a level that could support commercial development, the Department should become

an early partner of commercial companies to encourage the development of the technologies by the private sector.

- Incentives should be provided for the development of technologies that reduce waste generation, that lower costs of remediation, or that improve safety.
- The Department must link technology development to technology demonstration and utilization programs. At all stages of the process, efforts should be made to inform potential users of the existence and performance of newly developed technology.
- The technology-development process proposed by the Department includes multiple points of analysis and evaluation (gates) where further development must be justified. Analysis should include quantitative tools, such as risk analysis and cost-benefit analysis (to degrees of detail that depend on the stage of technology development).[3] Such analyses must be benchmarked against available technologies, technologies under development in the Department, and technologies available in the broader commercial sector.
- There has not been a strong relationship between technology development and basic research. Technology development (already strongly influenced by technology users) must be strongly coupled to research and development at both the basic and the applied levels. The Department has recently begun efforts to improve this relationship (between the Office of Energy Research and Environmental Management) and it should continue to make this relationship a strong interactive one whereby technology-development needs can influence how basic-research budgets are allocated and vice versa. As in the case of technology development, basic research should be performed by the most appropriate institution as determined by competitive peer review.
- The decision as to whether National Laboratories, universities, or industry should take the lead in the development of any particular technology should be based on a competitive process that undergoes external review, not by formula or some other form of entitlement. Often, forming teams or partners among the different groups for the development of a particular technology is the most effective approach.
- National Laboratories constitute an extraordinary technical resource both in capability and in size. It must be recognized, however, that the Laboratories are unique in culture and expertise (especially in the case of nuclear materials); this can be both an advantage and a disadvantage in bringing new technologies to bear in restoration activities. There must be strong external benchmarking

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[3] In cost-benefit analysis, costs should include both life-cycle costs and short-term costs. Life-cycle cost is an estimate of the full cost of implementing a technology over its expected life according to a discounted present-value analysis that uses various interest rates (including 0%). Benefits can include some of the following: decreasing risk of contamination for a population, increasing reliability of the method to contain pollution or to remediate, decreasing production of secondary waste, increasing safety of workers in the EM Program, and developing methods that might have wide use or commercial value.

and peer review within National Laboratories. The Laboratories must be open to procurement of outside capabilities even when the main body of the R&D fits within the Laboratories.

- As with all participants in technology development, the Laboratories should structure their efforts to be responsive to the technology customers.
- Many of the Department's waste-management issues are not peculiar to the Department—they are issues that are faced by private industries and by the Department of Defense as well. The Department should use fully the expertise and talent available in universities, industry, and other federal agencies. The role of industry and universities should have several elements: as sources of peer review, as collaborators in technology development, and as primary participants in technology development.

TECHNOLOGY UTILIZATION

- During testing and demonstration on a federal facility, the Department should indemnify a technology developer against an unplanned contamination of the environment, but not against failure to properly perform the work. Site operators and the local stakeholders who have taken risks in deciding to utilize innovative technology should be rewarded, not penalized, if a technology fails.
- All procurement approaches for developed technology must include provisions for testing and validation of technologies in the context of constraints of actual problems. The possibility of some degree of failure to meet target criteria or goals of well-conceived projects must be accommodated without excessive penalties.
- A group of competent, trained and experienced scientists, engineers, technicians, and support personnel must be maintained at Department sites to be able to judge the viability and facilitate the introduction of innovative technologies. It is essential in ensuring the successful introduction and utilization of technologies.
- In most cases, the site operating contractor must retain the responsibility of final approval for the use of proposed technology to the extent that it must ensure the health and safety of people both on the site and in the community around the sites and ensure preservation of the investment in the site.

Policy

The subcommittee believes that several issues must be addressed by DOE if it is to use scientific and engineering information successfully in its EM Program. It must have a vision of how it wishes to go about its mission activities. It must have clear and specific goals by which to accomplish its mission and do so in a way that fulfills its vision. There needs to be a clear decision-making process to support the establishment of goals and their implementation. This section discusses these topics.

THE VISION

US industry is refocusing and substantially broadening its vision of environmental management. The Department of Energy should do likewise. For current products and processes, that means setting pollution-prevention goals and acknowledging that the most effective way to reach them is to incorporate environmental criteria into experimental, process, and product designs.

The subcommittee recommends a life-cycle approach to ensure that environmental consideration is given to all processes and products, with a goal of eliminating or drastically reducing waste streams at every stage of the activity. In other words, the Department should pay more attention to the ''front end'' of the production cycle to minimize or eliminate what comes out the ''back end.'' Generally, it is much more effective from both environmental and cost standpoints to eliminate waste at the source (source reduction) than to try to reduce the volume or toxicity of waste once it is generated.

That approach is appropriate for both programmatic activities (e.g., materials-development research) and remedial activities (e.g., preparation of high-level waste in storage tanks for eventual disposal).

Implementing this strategy will require incentives and removal of disincentives. Programs and operational groups should be expected to pay for the waste they generate. The current budget for EM provides funds for waste disposal for both the various ongoing programmatic activities of the Department and remedial-action programs. When a materials-development research program has to make a decision about what process to use in the laboratory, it does not have to give consideration to the costs of disposal of different alternative waste streams, because the EM Program has programmatic and budget responsibility for waste disposal. The research program in this example has no incentive to internalize the costs of disposal. If the research program had to provide funds to EM for the services rendered for waste disposal, incentives for waste minimization by the researchers would be in place. Additionally, waste minimization and pollution prevention should be evaluation criteria in performance review. Programs and groups should be rewarded for reducing and eliminating waste. Funding requests should be biased in favor of projects that have a strong life-cycle waste-minimization and pollution-prevention component and toward researchers who have demonstrated relevant concerns. It might be useful to develop public-recognition schemes for successful researchers.

Environmental remediation and decommissioning should not affect health or the environment adversely. Consideration of the life-cycle environmental cost of different remediation options should be included in cost-benefit decisions.

GOALS

The president of Clean Sites, Edwin H. Clark, succinctly described the problem facing many within the EM Program, including Department employees, contractors, and local citizens: ''If you don't have hard statements of goals, it is difficult to figure out what to do to achieve them.''

The Department and EM have produced many statements of goals, such as that in the latest risk report: ''The primary focus of the [EM] program is to reduce the health and safety risks from radioactive and hazardous waste and contamination . . .'' (DOE, 1995d). These were valuable when first promulgated, to lay out the philosophy of the new administration. However, when they continue to be the primary goals, they become pious statements that cannot be used to make decisions at Department sites and facilities.

The Department should take the steps necessary to establish goals with sufficient specificity for decision-making. The goals should be set first at the national level with a clearly identified process that can be used to develop site-specific goals. They should incorporate land-use planning and enable risk-based and cost-based decision-making.

In the absence of clear and accepted goals, it should not be surprising that decisions are postponed or constantly revisited, that ''the remediation program has accomplished far less than many wish'' (DOE, 1995e), and that the Department ''has been severely criticized because of the small amount of visible cleanup that has been accomplished'' (DOE, 1995e).

One important example of a goal that needs greater specificity is just what level of cleanup is acceptable. ''How clean is clean enough?'' is not a new issue. It has been a prominent question at least since the passage of the National Environmental Protection Act (NEPA) in 1970. The question cannot be answered in the abstract or general sense. It is a site-specific decision incorporating many of the variables previously discussed. That few sites have determined those levels is a measure of the difficulty in doing so. However, as the Department remediation program reaches a funding level of many billions of dollars per year and the Department estimates that the program will last three-fourths of a century, this seemingly intractable issue must be addressed. Reasonable bounds of a range of such levels should be determined nationally.

We recognize that effective goals cannot be established simply by executive pronouncement. It requires involvement of the interested and affected parties. At the national level, EM could turn to the Environmental Management Advisory Board (EMAB) to recommend such goals; EMAB is composed of a broad range of people—technical experts, representatives of state governments, and local stakeholders. It might also be appropriate for the Department to propose establishing national goals by legislation, after development by the various stakeholders.

Another approach that might be tried is often used in industry when major changes are seen to be required. A small group of employees from different levels of the organization, including middle-level managers, are sent off for 6–12 months, relieved of all other responsibilities, and given the task of coming up with a solution to the major problem. A similar approach was used by the Environmental Protection Agency in its writing of *Unfinished Business*, in what became a fundamental study of EPA's allocation of efforts, to identify the disparity between what the agency's experts believed were the greatest risks and where EPA was focusing its resources, primarily in response to Congressional direction.

Without knowledge of land-use goals and cleanup-level goals, the identification of needed technology is difficult. There are ways to analyze situations that can help those making decisions about what technology to apply or develop, even when the goals are not final. The first report of the NRC Committee on Environmental Management Technology stated: ''Evaluation of technological alternatives and optimization should consider the systematic use of comparative risk and risk/benefit assessment'' (NRC, 1995). We recognize that EM recently, in response to a Congressional request, produced a first step in evaluating the risks associated with the many activities and facilities in the EM complex (*Risks and the Risk Debate: Searching for Common Ground ''The First Step''* (DOE, 1995d)). However, this is, as its title suggests, only a first step. EM should continue to develop a risk-based approach by having risk assessment done of the major activities under the EM umbrella. Risk assessment is especially useful when priorities must be set and decisions about human (worker and public) health and environmental health must be balanced against costs. The process should be open, so that the results will be understood by both the Department and stakeholders. It should undergo peer review by outside panels.

Risk assessments, which take several iterations to approach useful results, should compare the risks at the several major sites to enable prudent allocations of resources and to decide their sequence (NRC, 1994). Ultimately, the process should be capable of identifying the locations and situations that pose the most serious risks across the nation to the public, to workers at Department sites, and to the environment. Imminent risks should have the highest priority for action. For nonimminent risks, risk assessment should be used to identify the benefits of risk reduction as part of overall cost-benefit analyses, which should form the basis for further priority-setting and for the timely resolution of contamination problems that must be addressed as required by law or compliance agreements.

A serious obstacle to remediation of sites is that the major factors that contribute to high costs in the remediation program have not been identified. Without that information, it is impossible to structure a cost-effective technology-development program. But the identification of needed technology is not possible without land-use goals and cleanup-level goals. Risk assessment can provide a way to overcome this barrier. Such existing models as MEPAS and RESRAD can be used to determine the risks associated with the proposed process or technology and compare it to a base case, that is, the technology most likely to be used today without further development. The use of those models in the past has been sparse because too few data were available. In some cases, the calculations may be too poorly supported because the input data are not sufficient and the models may not fit well. An effort to combine existing cost and risk numbers for activities may nevertheless be useful, in connection with dialogue with stakeholders on priorities for site remediation. However, the cost and residual risk for this base case could be determined with data from the BEMR (DOE, 1995b) and *Risks and the Risk Debate: Searching for Common Ground* (DOE, 1995d) reports. From this base case, the factors contributing the most to costs could be identified with reasonable probability. Once identified, the ''cost drivers'' could be analyzed with the models mentioned above to estimate what cost and risk changes would result from changes in land-use goals, cleanup-level goals, and technology used. Standard decision theory can be used to see what is gained in risk reduction for each incremental increase in the cost of cleanup. The outcome of the process might well be a radical restructuring of goals, priorities, what is remediated, to what degree, and at what time. To be successful, such a process must be open, transparent, and inclusive from the very beginning. Stakeholders must be able to see the costs and risks associated with different options for the operation of Department facilities in their communities and for the remediation of different sites. In a number of situations where this information has been provided, stakeholders have supported decisions that would surprise critics of substantive stakeholder participation (for example, the far reaching land-use decisions at the Hanford, Washington and Fernald, Ohio sites that resulted from the deliberations of the Hanford Site Use Working Group and the Fernald Citizens Task Force, respectively).

At the local level, goals that are consistent with the national-level goals, but that take local factors into consideration, should be established. It might not be possible to establish national-level goals first, but it could be possible to reach local agreement. We recommend that EM continue to work with site contractors and stakeholders to establish waste-management and cleanup goals that are realistic, i.e., recognize health risks, resource constraints, and the state of technology. The approach being developed by several states to develop and test models for interstate cooperation on testing, evaluation, and permitting of innovative technologies, such as that under the auspices of the Western Governors Association (WGA), might accomplish some of those aims.

It should be recognized that the analytical approach to goal-setting for land use and cleanup levels described above is the basis for an iterative procedure or a comparative analysis that should be used to set priorities for technology development and to elucidate the effects of different land-use goals and cleanup-level goals. Exact values are not needed; the values need only be ranked. In an iterative process, a perfect analysis is not necessary at each stage. The important thing is to proceed, and that means not investing too much time and money in the process at the early stages.

The fact that the remediation process is going to continue for over 75 years, at a minimum, affects the approach to technology selection and development. Rushing to remediate now, instead of appropriately characterizing a site or developing a "better" technology, might be the most expensive approach to an already-expensive problem. Planning and technology development must be iterative because conditions will change and new developments will take place.

Moreover, there need not be the fixation to get it right the first time as the mix of remedies will change over time as the results of the remediation research become available. At that point the Records of Decision required by regulatory agencies and agreed to earlier on specific activities for remediation can also be changed (just as they are now being changed regularly).

Even in the absence of national goals for cleanup or land use, EM must function in many regulatory systems. Site actions must be consistent with state and federal laws; with compliance agreements among the Department of Energy, Environmental Protection Agency, and the states; with the wishes of citizen advisory groups; and with resource limitations. Such guidelines and limitations can be in conflict with each other or be unrealistic. The system has become overconstrained. The Department should attempt, as industry does, to take advantage of existing flexibility in laws and compliance agreements aggressively. However, industry does not have as many constraints as the Department; according to the report *Train Wreck Along the River of Money* (Blush and Heitman, 1995), the wishes of citizen advisory boards and compliance agreements among the Department, EPA, and states have resulted in this overconstrained situation. Pat Whitfield, a former senior Department of Energy official, stated at this subcommittee's workshop that the ''agreements were totally unrealistic on the day they were signed.'' Agreements should be changed, frank discussion must be held with site advisory groups, and legislation might be required.

Finally, goals should be set within a framework that provides incentives for agency officials and communities to make decisions. One suggestion was proposed in recent Congressional testimony on Superfund reauthorization: ''Communities might be more willing to accept lower cost remediation if a portion of the savings would accrue to the local communities for such things as infrastructure development, improved schools, etc.'' (Parker, 1995).

PROCESS

EM has completed useful efforts to implement a new approach to its decision-making processes for technology selection, development, and utilization (DOE, 1994), but the subcommittee noted that decisions are made on differing bases or in some cases even by default. As EM has acknowledged, an explicit, comprehensive approach is needed to identify technology-development needs, opportunities, and applications. As this process evolves, EM should consider the following points of emphasis:

- The types, scale, and scope of problems to be addressed should be clearly defined.
- The type of decision-making process to be used should be based on the performance outcomes desired. That will clarify whether the process needs to be iterative—moving from a screening level of analysis to a more-detailed (possibly more-quantitative and data-based) approach—and whether it should use relative or absolute standards of judgment.

- The essential elements or tools to be used in the process should be stated and defined. For example, risk assessment and cost-benefit analysis might be valuable in summarizing and synthesizing scientific, economic, and public-policy information.
- Specific criteria should be developed for each element of each step in the decision-making process.
- Input from focus-area staff, project-technology leads, external experts, and stakeholders might be needed at different points in the process.
- Peer review should be used in the decision-making process. The peer-review system should exclude those who might be considered to have a conflict of interest. The peer-review groups should include members from outside the Department. Members of external peer-review groups who later develop conflicts of interest should be quickly removed from peer status. A peer-review system with the highest standards would go far in changing the insular image of the Department held by many and the common impression that review of an extramural R&D proposal by Department staff constitutes peer review.
- Feedback should be obtained from technology decision-makers and users on the results of the process to ensure routine evaluation and timely improvement of decision-making processes.
- Incentives should be provided to ensure timely closure in decision-making processes.

Technology Selection and Development

CUSTOMER NEEDS

The selection of technologies for development beyond basic and applied research activities is a key step in the overall technology-development process of the Department. If technology selection is done properly, the selected technologies should be able to move through the complete development process and lead to solutions of identified problems. If it is done poorly, it can result in wasted resources, in customer dissatisfaction, and in lingering problems.

At its most fundamental level, successful technology development is a product of meeting customer needs by solving their problems to an acceptable degree. Where technology development takes place independently of customer (and stakeholder) needs, the rate of technology deployment is low. Where the needs of potential customers (and stakeholders) are identified and considered from the beginning of the development process, the likelihood of eventual technology acceptance and use is high.

The subcommittee recommends that the Department's technology-selection process be intimately linked with identified customer needs. We believe that the most important step that EM can take in this regard is to ensure that a structured process is implemented and consistently applied to require consideration of customer needs explicitly and seriously from the beginning of the process.

FOCUS AREAS

The EM technology-development program designated five priorities or ''focus areas'' for technology development:

- Mixed-waste characterization, treatment, and disposal.
- Radioactive tank-waste remediation.
- Contaminant plume, containment, and remediation.
- Landfill stabilization.
- Facility transitioning, decommission, and final disposition.

The purpose of the focused approach is to bring together users and developers to decrease cost, decrease risk, and do what ''cannot be done.'' In addition to the focus areas, the Department has identified several cross-cutting or common areas: characterization, monitoring, and sensors; efficient separations and processing; robotics; and technology transfer.

The subcommittee thinks that the focus areas that have been defined provide an appropriate structure for accomplishing this objective. The focus areas provide a forum for bringing together technology developers, technology users, potential industrial partners, and other stakeholders for the purpose of developing technical products that can meet customer requirements. We endorse and validate this approach as being closer to a market-driven or user-driven system than any technology-development procedure previously used by the Department.

However, we are concerned that implementation of the focus areas has fallen short of the intended mark primarily because user and customer requirements have not yet been fully integrated into the decision-making process for selecting new technologies. Some members of the subcommittee have observed a general indifference to the process on the part of the key Offices of EM. We recommend that steps be taken to ensure that user involvement in the focus areas is sufficient (and has sufficient expertise) to influence the early selection of technologies for development.

DECISION PROCESS FOR SELECTING CANDIDATE TECHNOLOGIES FOR DEVELOPMENT

The subcommittee is aware that EM is developing a decision-making framework that could potentially be used to select technologies for development by EM. We support the refinement of this framework and its eventual acceptance and use by the focus areas. The lack of an accepted and consistently applied framework is a distinct problem.

The framework must clearly identify who has the responsibility and authority to ask, answer, and make appropriate decisions regarding such fundamental technology-selection questions as the following:

- Is new technology needed to solve a given problem?
- Is technology that can adequately solve the problem available or under development (either inside or outside the Department)?
- If not, has the technical or scientific basis of any potential new technology that is being proposed been adequately demonstrated (theoretically or, better, experimentally)?
- Does the proposed new technology address a priority Department need that has been identified by a potential technology user or stakeholder (either at one site or at multiple sites)?
- How does the technology compare with other technologies that have been or are being developed elsewhere (including outside the Department complex)?
- Is there a compelling reason (i.e., related to potential for success, cost, ability to solve a difficult problem, etc.) why the Department (rather than someone else) should pursue development of the technology?

In addition, the framework needs to have an explicit link between the proposed technology development and customer needs as stated above.

The subcommittee recommends that the responsible person or entity for technology selection be clearly identified and that a knowledgeable peer-review group (which is independent and includes members from outside the Department, as discussed above) have substantial influence in the selection decision.

Because new technologies are constantly being developed, the decision-making framework must recognize that technology selection for the Department is a dynamic process that must be periodically revisited. Understanding of what kinds of technology are becoming available, not only from inside the Department but also from outside, is necessary.

Circumstances that must be accounted for in making technology-selection decisions change (e.g., funding levels may decline, the understanding of the health effects of different circumstances in the DOE complex may change, and the consequence for the environment may be better appreciated), so technology-selection decisions should be made with a view to achieving a strategic mix of technology developments that have short-term and longer-term payoffs.

TECHNOLOGY-DEVELOPMENT MODEL

The strategy of organizing EM technology development within focus areas offers the opportunity for radical redesign of procedures for development of new environmental-remediation technologies. To achieve optimal return from the new approach, a much-needed and fundamental paradigm shift for the EM technology-development program, a progressive conceptual model must be developed to guide and manage the process. Each focus area will have some special features and requirements, but the basic elements of the model will be more similar than different for the different focus areas. A model that divides technology-development projects into six categories or ''gates'' with screening criteria was discussed at the workshop. Gate 1 is the entrance for applied research, gate 2 is the entrance for exploratory development, gate 3 is the entrance for advanced development, gate 4 is the entrance for engineering development, gate 5 is the entrance for demonstration, and gate 6 is the entrance for implementation (see Figure 1).

Several specific requirements of the EM technology maturation model identified by the subcommittee should strengthen the EM technology-development effort.

Models for technology development must be strongly coupled to supporting research and development and to technology demonstration and utilization programs. That might be difficult to accomplish, considering the varied nature and dispersed organization of the research supported by the Department that is applicable to technology development. For example, the subsurface-science research program is not in EM, and most of the environmental-process research in EM is not in the Office of Technology Development. Nevertheless, because most new environmental-restoration technologies in several of the focus areas have their origins and underpinnings in environmental-process research (e.g., in transport, fate, and subsurface characteristics), a carefully nurtured, interactive relationship must be established between basic and applied research and technology development.

EM has recently begun an effort to coordinate its technology-development efforts with the Office of Energy Research, which houses much of the Department's basic research and is the principal office for interaction with nondefense Department National Laboratories. The Congress has allocated $50 million of EM Program funds for this effort. This type of linkage, including the defense-related Laboratories, where much of the expertise in nuclear materials resides, is precisely what is called for by this subcommittee. The Department should extend this attempt to create partnerships to include the basic-research efforts in universities and industrial concerns that are developing technology or undertaking their own research.

As with any program initiative in the Department that involves many groups with their own programmatic objectives (e.g., basic research in support of the Department's missions versus applied research for specific projects), it can be difficult to create an effective link between basic research and the needs of a specific program, such as the EM Program. A principal challenge to its success will be to convince all those who have managerial responsibility for the different groups that this shared initiative deserves their support and encouragement. The Department should provide incentives to its managers, Laboratories, and contractors to make initiatives like this a success.

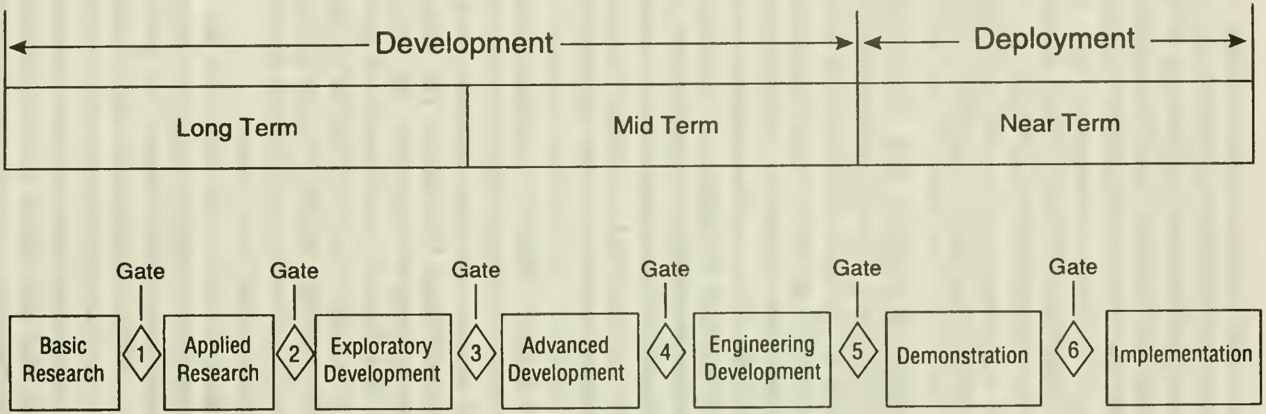

FIGURE 1 Gated Evaluation Process.

SOURCE: Gretchen McCabe, Battelle. Presentation at the National Academy of Sciences, July 12, 1995.

A way must be found to empower environmental-technology users to participate effectively in the allocation of applied-research and technology-development funding, regardless of the source in the Department.

Technology development must be tightly coupled to technology demonstration and user implementation if the barriers to the introduction of new technology are to be overcome. A mechanism that has proved effective in overcoming a number of barriers is stakeholder involvement from technology selection through all stages of development to final implementation. *Stakeholder* must also be broadly defined and include not only R&D and user personnel, but regulators at all levels, permit writers, and the public.

As emphasized above, a productive technology-development model must also be based on clearly articulated goals and analyses to determine whether the goals are likely to be achieved. Analyses should be included at multiple points in the development process to justify continued investment. Life-cycle costs of technologies in development should be subjected to economic analysis, and the potential risk reduction likely to result from the technology should be analyzed before huge sums are invested.

Cost analyses must be benchmarked against available technologies or other technologies under development, regardless of the sponsor. That will require EM to improve its research and technology-development outreach by opening the Department's R&D program to all qualified persons and organizations, regardless of type or location.

The subcommittee believes that technology-development funds should be awarded on a competitive basis. Creative partnerships between industry, academe, and National Laboratories should be encouraged.

Many of the Department's waste-management issues are not peculiar to the Department; they are faced by private industries and the Department of Defense as well. The Department should make full use of the expertise and talent in universities, industry, and other federal agencies. The role of industry and universities should be of several kinds:

- External peer review.
- Collaboration in technology development.
- Primary participation in technology development.

As with the technology-selection process, development should incorporate a broad-based system of peer review that is carefully implemented and monitored to ensure equity.

A system of incentives must be developed to increase the likelihood that new technologies will be implemented. Stakeholder involvement will help, but other approaches should be considered such as grants to communities that cooperate in the demonstration of new technologies.

COST-BENEFIT ANALYSIS AS PART OF THE TECHNOLOGY-DEVELOPMENT PROCESS

Calculation of costs and benefits takes into account a number of factors. Costs should include life-cycle costs, as well as shorter-term costs. Life-cycle cost is an estimate of the full cost of implementing the technology over its expected life; estimation uses a discounted present value analysis (in its most useful form, a range of interest rates, including 0.0%, are used). This allows comparison of short-term capital intensive technologies with longer-term, more cost-effective technologies on an equal basis. Examples of benefits are: decreased likelihood that contamination will reach or affect a population, increased reliability of the method for containing pollution or remediating, decreased production of secondary waste, increasing safety for workers in the environmental management program, and development of a method that might have wide use or commercial viability. As with any analytical tool of this kind, life-cycle analysis has its critics. DOE should use it with this in mind, be certain to make clear statements about the assumptions used, and seek participation of stakeholders in making judgments about these assumptions.

Cost-benefit analysis should be included at each step of the research and technology-development process in the Department. Obviously, the proof of effectiveness should be much less stringent and detailed for basic and applied research and for exploratory development than would be required for more-advanced stages of technology development.

The technology-development model with screening criteria was presented at the workshop by Gretchen McCabe of Battelle (see Figure 1, above). The general approach embodied in the screening criteria was supported by the subcommittee. Although many variants of this model are possible, it serves the purpose of making a few general points. In the model presented, cost-benefit analysis is used to determine whether a project passes the fourth gate from ''advanced development'' to ''engineering development,'' which involves prototype development and testing. Incorporation of cost-benefit analysis at this stage in the process is appropriate, but as stated above, it should be applied throughout the process and with different levels of detail, depending on the uncertainties associated with the particular stage of development.

The level of detail required for cost-benefit analysis is different at different levels of technology development. For projects in the basic-research, applied-research, or exploratory-development stage, there should be a description of scientific reasons for expecting costs to be reduced if the project is developed and of benefits (with respect to risk reduction, cleanup time, and reduction of secondary wastes) that can be expected if the project is successful. The scientific basis for expecting specific benefits needs to be explained. The issues that will substantially affect costs and benefits should be identified as early as possible in the technology-development process.

For more-advanced projects (gates 4, 5, and 6), the level of detail about costs and benefits should be increased. Claims of cost savings or benefits should be documented. At this point, information on the expected implementation of the technology should be sufficient for estimating the life-cycle cost for some generic or site-specific examples. It should also allow estimation of hidden implementation costs. In the assessment of these more-mature projects (gates 4–6), specific cost-benefit goals should be stated; e.g., a working target might be to remove cadmium from soil at a cost 20% less than the cost of current landfill solutions or to remove a contaminant from groundwater at a rate 30% faster and at no higher cost than a current-pump-and-treat strategy. The decision to fund further technology-development projects will be based in part on the stated goals and the ability of the projects to meet goals declared at earlier gates. There should be at all stages a comparison of the costs and benefits of using the new technology and established technologies for the same pollution problem.

For example, aquifer characteristics, such as hydraulic conductivity might be known to have a major effect on the feasibility and cost of a particular bioremediation technology. Hydraulic conductivity is a measure of how easily water moves through soil; it varies widely between soil types. In this example, proposals for bioremediation programs in the early stages (e.g., research or exploratory development) should identify this important property of soils and discuss how the issue will be considered in the analysis. Proposals for more advanced work (advanced or engineering development and beyond) should be able to measure the impact of hydraulic conductivity on feasibility and cost. In addition, consideration of the applicability of a particular technology should include a discussion of the impact of this factor (e.g., how large the market for this type of technology is, given the conductivity requirements). For most projects, several such issues need to be identified early in development and continually revisited with increasingly detailed analysis as the technology passes through the various gates.

Peer reviewers should have information about the costs and benefits of a technology project in comparison with those of other existing technologies to assist them in their evaluations.

ROLE OF THE NATIONAL LABORATORIES IN TECHNOLOGY DEVELOPMENT

The decision as to whether National Laboratories, universities, or industry should take the lead in the development of any particular technology should be based on a competitive process that undergoes external review, not on a formula or some other form of entitlement. Often, teaming together and partnering different groups for the development of a particular technology is the most effective approach.

National Laboratories constitute an extraordinary technical resource in both capability and size. It must be recognized, however, that they are unique in culture and expertise (especially with nuclear materials); this can be both an advantage and a disadvantage in bringing new technologies to bear in restoration activities. There must be strong external benchmarking and peer review of research and technology-development efforts in National Laboratories. The Laboratories must be open to procurement of ''outside'' capabilities even when the main body of the R&D fits inside. As with all participants in the technology-development effort, a Laboratory should structure efforts to be responsive to the technology customers.

Experience has demonstrated time and again that the National Laboratories are most effective at producing technologies that have potential for commercialization when they are linked to industry at the earliest possible time. The idea is for industry to provide ''technology pull'' that can guide R&D so that a product meets customer requirements and there are no surprises when it is turned over to industry for commercialization.

Partnerships between industry, the Laboratories, and universities in which each party contributes what it does best may be desirable.[4] The National Laboratories, for example, have extraordinary expertise in simulation and modeling, advanced materials, chemistry, fluid dynamics, and other disciplines of potential interest to industry. Furthermore, the Laboratories have officially designated user facilities—usually one-of-a-kind instruments or Laboratories that are available for industrial collaboration with a minimum of paperwork and bureaucracy.

Other models for technology development have not been very successful. Technologies that are developed without industry participation face a much more difficult road to commercialization for a variety of reasons, ranging from difficulty of manufacture to the ''not invented here'' syndrome where a company is not interested in developing a technology because it had nothing to do with its earliest development.

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[4] An example of this partnership model is developing at the Los Alamos National Laboratory. In early 1995, Motorola approached the Laboratory about developing technologies for cleanup of solvent-contaminated groundwater. Motorola visited the Laboratory on several occasions to inform Laboratory scientists and engineers of the customer requirements, including providing information on the extent of the problem and possible approaches that would be acceptable in the existing corporate and regulatory environment. The Laboratory plans to allocate some of its FY 1996 laboratory-directed research and development funds to start a small number of projects that will be conducted with expanded industry involvement, including that of Motorola and other interested companies. If promising solutions can be developed during the coming year, Motorola has agreed to lead a program-development effort for continued funding.

Technology Utilization

The magnitude and diversity of Department waste-management problems dictate that there be a hierarchy of approaches to deciding where and when technologies are used or developed. The hierarchy should apply even within a technology-selection process like that described above. These approaches can be categorized according to the nature of the remediation activity as

- Technologies related to interim waste-management measures, such as those needed to maintain burial grounds, existing facilities, waste repositories, and plant-waste treatment systems until a final remediation option is agreed on and effected.
- Technologies related to final remediation of wastes, such as those needed for processing waste-tank contents, producing final waste forms, and decontaminating and decommissioning equipment and facilities. It is important to note here that the EM Program must define final waste forms in collaboration with the Office of Civilian Radioactive Waste Disposal if it is to guide the development of these technologies properly.
- Technologies needed in connection with custodial activities, including a wide spectrum of instrumentation for monitoring and isolating sites that must still be retained by the Department.

Which technology approach to pursue will be determined by which goals (such as land use and cleanup levels) are selected and what level of priority a particular site or remediation activity receives on the basis of the magnitude of associated risks and cost-benefit rating.

There are several ways to obtain technologies. The best approach will depend upon whether the problem is peculiar to Department sites, is not peculiar to Department sites but poses a need for improved technologies and processes for remediation, or can be solved with existing technologies supplied by private companies.

It is important to establish an explicit policy to encourage private-company participation in solving problems in the first two categories. Successful participation in the first category will mean that the waste-management experience of the private sector will be shared and market-driven management principles will be brought to the problem. In the second category, involvement of the private sector might lead to the development of a process or technology that gains broader commercial-market acceptance.

For private companies to enter the technology market for Department waste problems successfully, they must have or develop an adequate and secure financial base, a facility for manufacturing and distributing equipment, and a good understanding of the regulatory and liability aspects of doing business with the Department. If any of those requirements are missing, the Department should be prepared to assist the companies if it finds the technology desirable. The technology must be both ''robust'' and safe. In all procurement approaches, there must be provisions for testing and validation of technologies in real-world conditions. The possibility of failure to meet target criteria or goals must be accommodated without excessive penalties. In fact, what is learned from failure can sometimes be as valuable as success would have been. The Department should indemnify a technology developer during test and demonstration against an unplanned contamination of the environment, but not against failure to properly perform the work. The site operator and the local stakeholders who have taken risks in deciding to use innovative technology should be rewarded, not penalized, if the technology fails.

When the point is reached where technology procurement is required it is essential that the responsible, knowledgeable people at the individual sites be intimately involved in defining the bounds of the problem. It is necessary to have trained, experienced, competent people; support organizations to ensure the health and safety of personnel; and management and maintenance functions to sustain the site infrastructure. In most cases, the site-operating contractor must retain the right of final approval of the proposed technology, to the extent that it can ensure the health and safety of people both on the site and in the community around the site, so that it can ensure preservation of its investment in the site.

Technologies exist both in the Department complex and in private industry to deal with many of the Department's waste problems. Some problems, however, are so complex that there is no identifiable technological solution. A possible way to deal with such problems is to break them into smaller problems. That creates a requirement for important systems analyses and technology-interface studies before decisions on technology procurement can be made.

It is especially important that narrowly defined solutions to individual problems not create or exacerbate other problems. For example, technologies for treating Hanford tank wastes might very well remove wastes from the tanks, but the resulting product streams could be very expensive to vitrify or could lead to excessive volumes of waste. It is critical to consider the waste problem and its solution broadly enough for the solution chosen to deal effectively and acceptably with the whole problem in a systems context. It does little to solve the Hanford tank-waste problem (although it may help some in reducing worker risks) by emptying the tanks to within 99% of total cleanup if there has been significant leakage from the tanks already into the surrounding soil. In a case like that, barrier technology to isolate the tank farm might be preferable to technology for cleaning out the tanks and separating the waste constituents for individual disposal.

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Appendix
PREVIOUS STUDIES

The titles and brief summaries of many of the studies on improving technology development follow.

1. *Status and Analysis of Environmental Technology Management at DOE*, October 1994. The report summarizes major observations made in analyzing the technology-development efforts of the Office of Waste Management, the Office of Environmental Restoration, and the Office of Technology Development and makes recommendations on the basis of some of these observations. Among the observations are the following: technology developers must recognize that environmental technology is needed now for field application to problems that pose a threat, industrial partners must be involved, most of the Department's technology-development efforts are directed toward the enhancement of existing technologies, and a considerable number of environmental technologies and services available in the private sector can be applied now to the Department's environmental-restoration needs. The Department is implementing a new approach to environmental technology and development that will correct some of the conditions observed. The new structure is aimed at reducing redundancy, increasing communication, and coordinating and streamlining the process of technology development and management better.

2. *Barriers to Environmental Technology Commercialization*, Environmental Management Advisory Board, Technology Development and Transfer Subcommittee, April 1995. The subcommittee categorized the numerous complex

barriers into two broad groups: primary barriers, which the Department can influence substantially; and secondary barriers, which are more generic. Examples of identified primary barriers are lack of adequate Department-site characterizations, insufficient technology performance or cost data, and cumbersome Department contracting and procurement requirements. Examples of identified secondary barriers are lack of entrepreneurial management, lack of adequate development funding, lack of consistent regulatory enforcement, and limited technology applications for the private sector. Some of the secondary barriers are acknowledged to be outside the realm of the Department. The subcommittee also acknowledges that developing new environmental technologies to reach the marketplace is a battle. The subcommittee recommends the acceleration of assessments of Department-site contamination to provide faster definition of technology and market needs, strengthening of the linkage between technology development and technology deployment, and continuation of aggressive collaborative efforts with EPA and states to resolve or reduce major impediments to permitting.

3. *Committee on Environmental Management Technologies Report for the Period Ending December 31, 1994*, NRC, Board on Radioactive Waste Management, Commission on Geosciences, Environment, and Resources, 1995. The first report of this committee supports EM's attempts to find generic solutions to major environmental problems through integration of the activities of EM-30, EM-40, EM-50, and EM-60 and encourages EM to continue to focus R&D efforts on clearly identified problems. The committee also recommends the development of new technologies as backups to current technologies.

4. *Federal Environmental Research and Development*, Carnegie Commission on Science, Technology, and Government, 1992. The report recognizes that the federal government generally lacks a coordinated approach toward environmental R&D. That lack makes it difficult to establish budget priorities and conduct efficient and effective research.

5. *Preparing for the Future Through Science and Technology: An Agenda for Environmental and Natural Resources*, National Science and Technology Council, Committee on Environment and Natural Resources, March 1995. The report divides research in the areas of toxic substances and wastes into risk assessment and risk management (pollution prevention, controls, remediation, and monitoring). Subjects of ''enhanced emphasis'' named in the report include improving risk-assessment capabilities and improving risk-management tools. The report emphasizes the need for developing more cost-effective means of remediating short-term environmental problems. The report recommends accelerating the diffusion of new technologies into the marketplace through partnerships with industry, state and local governments, academe, and nongovernment organizations.

6. *Report of the Defense Science Board Task Force on Environmental Security*, Department of Defense, Office of the Under Secretary of Defense, Acquisition and Technology, April 1995. The DOD environmental-remediation effort costs billions of dollars per year. Among the subjects for improvement that the report addresses is accelerating environmental-technology development and deployment. It notes that many existing technologies offer risk-reduction and cost-reduction potentials that are not being realized, partly because of regulatory barriers. It identifies the barriers to deployment of new environmental technology as forming the most serious bottleneck and expresses concern that with today's shrinking environmental budgets, investments in environmental science and technology that could substantially reduce future costs will not be made. The group made several recommendations for accelerating technology development and deployment. Among them are devoting an additional $150 million per year for accelerated environmental-technology demonstration and verification, making assignment of responsibility clear, developing a set of incentives for federal-site directors to use new technologies, and expanding cooperation among agencies and with industry.

7. *Alternative Futures for the Department of Energy Laboratories*, February 1995. Secretary of Energy Advisory Board, Chapter III, "The Energy, Environment, and Related Sciences and Engineering Role." This report, also known as the Galvin report, examines the role of the Department's National Laboratories. This section reviewed the Department's EM Program and addressed the Laboratories' energy and environmental roles and strongly criticized the EM Program. One of the most important challenges facing the Department and its Laboratories, as noted in the report, is to achieve greater integration of its various applied and fundamental energy R&D programs. Many facets of research and technology development constitute the appropriate energy agenda for the Laboratories.

8. *Management Changes Needed to Expand Use of Innovative Cleanup Technologies*, U.S. General Accounting Office, August 1994. The report identifies internal and external barriers to the use of new environmental technologies. It notes that although the Department has spent a large amount to develop waste-cleanup technology, little new technology is being incorporated into the agency's cleanup actions. Part of the agency's problem, the report notes, is that the Department does not have a well-coordinated and fully integrated technology-development program. The Department's plan to restructure its technology development programs is a step toward alleviating these problems. In addition, field offices will consider new and innovative technologies more seriously.

9. *Cleaning Up the Department of Energy's Nuclear Weapons Complex*, Congressional Budget Office, May 1994. The report outlines the Department's environmental problems and its cleanup program, including such policy issues as understanding risks, weighing costs and benefits, setting priorities, and

investing in the development of better technologies. The report acknowledges that the Department's cleanup program must address a problem that was created and largely ignored over the last 50 years. The Department is faced with addressing that problem during an especially tight budget climate. The report suggests that understanding of risks and costs better would be the best way to determine priorities for allocating scarce cleanup funds. It recommends investing more heavily in technology development, delaying technically difficult projects, and cutting overhead costs to improve the efficiency of cleanup efforts. In addition, new management systems might help the Department and Congress track the performance of cleanup projects.

Part V

Integration of Science, Engineering, and Health in Program Implementation

SUBCOMMITTEE ON INTEGRATION OF SCIENCE, ENGINEERING, AND HEALTH IN PROGRAM IMPLEMENTATION

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Introduction

The subcommittee held a 1.5-day workshop on August 29 and 30, 1995, to meet with representatives of industry, Department of Energy (DOE) Environmental Management (EM) Program officials, Department of Defense (DOD) officials, and personnel from Department of Energy contractors. The subcommittee was impressed by the degree to which the Department of Energy has recognized many of the key issues inhibiting the success of the EM Program. The Subcommittee identified and directed its attention to four subjects which would be most helpful in improving the integration of science, technology, and engineering into the EM Program:

- *The Department's management system, including its relationship to contractors and regulators.* The subcommittee noted that the organizational structure of DOE bifurcates responsibility for environmental management; thus decision-making and incentive-system processes are not optimally designed to help the EM Program meet its stated goals.
- *The management of remediation-related research and development and its relationship to the Department of Energy's field activities.* Needs-based research should be well coordinated and integrated into activities in the EM Program.
- *Environmental practices in industry.* Several subcommittee members have experience in this regard, and the subcommittee heard from industrial representatives. For most companies, cleanup is a necessary sideline: they must do it well, finish the job, and let the rest of the company focus on its core business. Industrial cleanup has a well-defined objective. In the Department, the EM Program faces many long-term challenges and the

program could easily be plagued by inefficiency if it becomes a self-perpetuating entity that is not managed carefully to attain its many independent goals (with completion of site remediation being just one among many).

- *The relationship between scientific and technical information and effective public participation.* Better communication and more meaningful, timely opportunities for public involvement are needed.

As the subcommittee focused on those subjects, it kept in mind the Department of Energy's stated goals of protection of public health and the environment, compliance with all regulatory requirements, efficiency, and cost-effectiveness. The subcommittee was struck by the difficulty faced by the Department in trying to establish and manage a program that must operate over several decades, especially in light of changing political leadership and congressional decisions. It also recognized the crucial inter-relationship between good management practices and the ability to integrate science and technology into decision-making. That led it to several recommendations for identifying the best business practices to create a climate for integration. In developing the recommendations, it acknowledged several factors that distinguish the Department's EM Program from private industry and therefore affect the agency's ability to adopt a business model fully, including the expectations of and demands on a public agency, the Department's history of self-regulation and poor management practices, and especially the unique challenges posed by radioactive waste and fissile materials.

The subcommittee was impressed with the degree to which the Department's leadership recognizes the need for improvement. The Department is currently in an active, transitional state, attempting to instill cultural and organizational change in the EM Program. Specifically, the EM Program is realigning its activities to meet the six goals set forth by Assistant Secretary Thomas Grumbly:

- Eliminate and manage urgent risks in the system.
- Emphasize health and safety for workers and the public.
- Establish a system that is managerially and financially in control.
- Demonstrate tangible results.
- Focus technology development on identifying and overcoming obstacles to progress.
- Establish a stronger partnership between the Department and its stakeholders.

One example of how the program is attempting to achieve its goals is the introduction of contract reform. Several basic elements of this reform are increased competition; renewed focus on the protection of workers, the public, and the environment; a results-oriented focus; and performance-based incentives.

In recent months, a performance based integrated contract adopting these elements of contract reform has been introduced and implemented at the Rocky Flats Environmental Technology Site in Colorado (*Independent Technical Review of Rocky Flats Program*, June 1995). Some workshop participants emphasized that it is too early to predict the effectiveness of the new contract, but subcommittee members strongly supported the intentions and direction of the contract-reform effort. The contract for the Savannah River Site in South Carolina is also being re-bid with several of the reform elements, but only the current contractor has opted to bid.

Other initiatives are rapidly introducing additional change into a system that was established during the Cold War. Some of the more notable efforts as previously discussed include integration of risk and long-term cost data into the budget process, addressing land-use planning at several Department sites, and realigning internal organizations. Although it is too early to assess how effective and long-lasting these efforts will be, the principles and general direction of reform are encouraging.

Internal Management and Contractor Relations

Some fundamental concepts must be addressed by any organization if it is to accomplish its stated goals. First, there must be effective leadership and a clear understanding by all involved about the goals of the organization, including its immediate and longer-term plans for accomplishing them. Next, an organizational structure must be established and management tools implemented to execute the plans and accomplish the goals. The subcommittee approached its discussion of the integration of science, engineering, and health in the internal management and organization of the EM Program, by addressing the framework for management and contractor relations, namely: leadership, goals, products and services, management tools, management structure, and incentives and disincentives.

LEADERSHIP

Issue: The EM Program must have strong leadership and, when necessary, attention from the Secretary of Energy.

The key to good leadership is the empowerment of those within an organization to make and be responsible for decisions in a way that promotes the accomplishment of the organization's goals.

The EM Program uses more than one-third of the Department of Energy budget. The importance of the environmental activities and the high degree of community concern over the safety of Department facilities dictate that the Secretary of Energy take a leadership role, through personal involvement, on select issues for the EM Program. The present Secretary initiated such activities early in her term through active involvement with affected communities. It will be important, as the Department focuses on facility management policies, for the Secretary to lead the way in pursuing and maintaining active progress.

The Secretary, through her emphasis on total quality management, has sought to clearly assign responsibility for performance. However, the current reporting structure through two different lines of authority involving both the offices of Environmental Management and Field Management (see Management Structure section) makes it difficult to implement the necessary accountability within the Department. Clarification of lines of responsibility will promote identification of responsible managers and minimize the phenomenon known as ''stovepiping'' where different organizational units within the EM Program share responsibility yet have little communication. It should lead to improvements in the mechanisms for raising, considering, and resolving EM issues that cross organizational units and will help develop a more focused agenda for the EM Program.

Recommendations:

1. Clearly, one of the principal roles of the Secretary is in setting the Department's major environmental goals. She also has the responsibility for empowering Department staff to accomplish those goals, making cross-program decisions, and taking decisions that require coordination with other departments to the appropriate interagency forum or to the President. There is a need for continued and strengthened leadership by the Secretary.

2. An organizational structure that places responsibility for deciding and executing programmatic priorities as discussed under ''Management Structure'' would facilitate EM Program efforts to integrate its science, technology, and engineering needs and missions with those of the rest of the Department. DOE is making efforts in this direction. This organization chart should be structured to serve operational needs and should, when necessary, create functional teams to address cross-organizational issues. All operational activities should be within the control of line managers. (See also sections on Management Structure, subsection B, and Lessons from Industrial Management Programs, section IV.)

MANAGEMENT STRUCTURE

Issue: Bifurcated responsibility for EM activities unnecessarily complicate the reporting structure.

The lines of responsibility for the conduct of the EM Program are diffuse within the Department. The organization chart divides the responsibility for conducting the EM Program between the Associate Deputy Secretary for Field Management, who reports to the Deputy Secretary, and the Assistant Secretary for Environmental Management, who reports to the Undersecretary. Contract management and procurement is the responsibility of the Associate Deputy Secretary, and programmatic direction and budgeting is the responsibility of the Assistant Secretary for Environmental Management.

The field offices are at eight sites, including the five that consume 70% of the budget of the EM Program. According to the August 3, 1995, issue of the *EM Alignment Initiative Newsletter*, the Assistant Secretary for Environmental Management stated, ''We are responsible for program development and program direction.'' The field is responsible for program execution. There are few mechanisms for the Assistant Secretary to hold the field accountable for implementing the EM Program's goals. Those who instigate an operation, such as the remediation of the high-level nuclear waste tanks at Hanford or a cleanup design, generally do not have responsibility to oversee the actual cleanup operation, because the contract operators do not report to the Assistant Secretary for EM. The responsibility loop apparently never closes in the existing structure until it reaches the Secretary's level.

Recommendation:

The line of responsibility for all environmental activities should be in one reporting structure within the Department with authority following the responsibility lines. This change would clarify accountability and facilitate integrated consideration of environmental activities. If the Department substituted a carefully crafted matrix organization, common in many corporations, bifurcation of management responsibility might work, although admittedly it is one of the most difficult organizational structures to make effective and must never be a substitute for clear lines of authority and responsibility.

Issue: The present organizational structure in the Office of the Assistant Secretary for EM has demarcations that prevents consideration of optimal system-wide solutions.

A waste tank and its contents, for example, might involve every major EM office, as well as other DOE offices. The waste could be generated by DOE's Office of Defense Programs or Nuclear Energy; EM's Office of Waste Management, Facility Transition, or Environmental Remediation; or another office entirely. The tank contents and its treatment, storage, and disposal would be managed by EM's Office of Waste Management. Response to a spill or leak could be handled by the site's emergency response team which might be operated out of different offices at various DOE sites. Disposition of the tank itself after emptying would likely be the responsibility of EM's Office of Environmental Remediation or Facility Transition. Any contaminated soil or groundwater associated with the tank and its contents would be the responsibility of EM's Office of Environmental Remediation. There are, unfortunately, few incentives or mechanisms to encourage systematic approaches involving multi-program teams, to manage the waste tank, its contents, and the surrounding environment.

Recommendation:

Environmental activities should be handled by teams that are organized around functional needs and site-specific programs. The introduction of organizational barriers that inhibit the application of good scientific principles should be avoided. A paradigm for consideration is the team approach used by industry. For example, teams may be composed of technical, legal, and financial managers. Depending on the stage of a project, the lead person for the project could be any one of those. The team can be supplemented by R&D, state government-relations, public-relations, real-estate, and construction personnel. That approach ensures a coordinated legal, technical, and financial strategy. The Office of Technology Development in DOE has recently established five Focus Areas in which to manage technology development and research on a team basis. That effort, in its initial stages, might demonstrate the utility of such a management approach, and lessons learned from it should be applied to the broad team concept suggested here.

GOALS

Often in government, middle- and lower-level staff lack a clear understanding of the ultimate purposes of the programs for whose execution they are responsible; a result is that outdated programs continue or dubious practices are continued on the feeble grounds that ''we're just following orders'' (from Congress, from higher officials, etc.). If the staff does understand the purposes of the programs at the outset, their understanding sometimes attenuates with time leading to similar results. To overcome that problem, the leadership of a department must constantly emphasize the importance of the department's goals. Successful departments ensure that discussions of work plans begin with a review of the goals that they serve. They encourage challenges to constraints that preclude achievement of those goals, including political constraints, and recognize that the political leadership within the department bears the responsibility for raising and debating these constraining issues with vigor.

Issue: Some goals of the EM Program are unstated, and these sometimes conflict with the stated goals.

This has complicated and slowed efforts to achieve the Department's long-term objectives for reducing risks to the public, workers, and the environment.

The stated goal of the cleanup is to reduce risk at the site quickly and efficiently. However, an often unstated goal is to provide continued employment and funding for the site. Organizational structures and decision-making by contractors and EM employees that would accelerate remediation or reduce the number of people required to carry it out could result in reduced employment or funding. Under the current system, states and local governments want to see rapid action toward achieving safer sites and safer operation of them, but they also want maximal employment at Department sites. Labor unions and contractors also benefit from larger and slower programs.

Recommendations:

1. All goals should be clearly identified, ranked, and communicated in writing, and the organizational structure should facilitate the achievement of those goals. The goals should be sufficiently defined to stand as milestones against which performance can be measured.
2. New incentive systems (for stakeholders, contractors, and workers) for rewarding better performance as measured against the goals should be explored.
3. States, tribal, and local governments should continue to be encouraged to participate in the EM planning and budget process so that they can become aware of and adapt to the budget pressures and other realities faced by the program.

PRODUCTS AND SERVICES

Once an organization has established its overall goals and the plans for achieving them, it can determine the activities or ''products and services'' that it will pursue day by day. Some are obvious and others are harder to define. In the case of the EM Program, remediation and waste-minimization activities are obviously essential for accomplishing the fundamental objective of the program.

Technology development, on the other hand, is an example of a product or service with a less well-defined role. Should the program pursue its own projects for the development of technology or leave decisions on technology development to the contractors that are carrying out the remediation effort? Should decisions about whether to pursue processes and technology for waste minimization throughout the Department's operations be made by the EM Program or left to the Offices of Energy Research and Defense Programs that operate the facilities? How such questions are answered will be affected by outside circumstances, such as the newly imposed financial restraint on the EM Program. The EM Program now hopes to reduce its expenditures by $10 billion for the period 1995–2000 through improvements in efficiency.

Issue: EM products and services are not fully defined, and changing external forces complicate efforts to define them.

The EM Program is still defining the less-obvious products that it should be producing (e.g., its technology development process). The EM Program is being forced to change its approach to its long-term goals because of appropriate demands for fiscal restraint and the ever-increasing pressure to accomplish its goals faster and more cost-effectively, and there is confusion as to what the near-term objectives of the program should be. For instance, does the technology development program exist to do basic research or to develop market-oriented technologies? The Department recognizes the need to identify technology gaps so that R&D can begin, but what constitutes a ''gap'' is not clear. Is the EM Program seeking to develop technology only as necessary for a particular waste minimization activity or environmental problem that currently has no solution? Is the goal to develop only technology that will reduce the cost or increase the speed of remediation activities? Or is it to reduce worker risks? Efforts to identify technology gaps in a coordinated agency-wide manner have resulted in a proliferation of reports, most of which have not provided a totally acceptable road map for action; e.g., *Hanford Integrated Planning Process: 1993 Hanford Site Specific Science and Technology Plan* (DOE, 1993a) and the *Technology Needs Crosswalk Report* (DOE, 1993b) were used only superficially after their publication.

A further problem that arises from the confusion is that without a clear understanding of what the Environmental Management Program needs to produce to meet its long-term goals, it is very difficult to determine program or employee productivity.

Recommendations:

1. EM, in revisiting its goal-setting process, should determine what services or products it must deliver, and establish goals that reflect the new budget pressures. The goals must be sufficiently detailed to lessen confusion about how to design products and services to attain them.
2. To that end, the EM Program should continue to ''benchmark'' itself against industry. It might want to benchmark against the electric-utility and telephone industries which are in the midst of redefining services in a more cost-conscious environment.

MANAGEMENT TOOLS

Former Secretary of Energy James Watkins wrote to the subcommittee that ''there are as many philosophies of organization and management as there are managers.'' Similarly, there are many tools for implementing a given management scheme. The subcommittee has focused on a few tools that could be helpful to the EM Program. Some are already being used. EM recognizes that its costs and time to reach milestones are excessive and is to be commended for beginning a process of benchmarking and using private-sector advisers to review its activities (see, for example, *DOE February Benchmarking Meeting and Independent Technical Review of Three Waste Minimization and Management Programs*, August 1995).

Issue: New Roles for EM staff require new skills.

In the past, the Department has relied on a system of relatively independent national laboratories and defense production facilities to accomplish its research and defense missions. With the new challenge of technically difficult and expensive environmental activities, the Department has begun to look at new models for managing this effort. The EM Program is rebidding over $27 billion in contracts and renegotiating another $13.5 billion. Federal employees in the EM Program will need new technical and managerial skills, especially in the oversight of performance-based contracts, in contrast with the older cost-plus contracts.

Recommendations:

1. The managerial and technical needs of the EM Program should be analyzed to ensure that the Department and its current management and site operators have personnel skilled in negotiations to oversee their contracts. It might also be necessary for the EM Program to define and educate program and project managers about their roles in the administration of EM activities.
2. As discussed at the workshop, the Department might need to become more assertive in its dealings with contractors. A good institution for comparison might be the Department of Defense, where new contract and management activities for environmental programs have been implemented.

Issue: EM should complete the establishment of a priority-setting system.

Recommendations:

1. EM's priority-setting system must consider a wide range of factors, including risk. Elements that should be evaluated when considering risk include

- Immediacy of risk.
- Extent of risk to human health and the environment.
- Cost, availability, and effectiveness of existing technology.
- Likelihood of success, timing, cost, and effectiveness of new technologies.
- Community pressures for immediate actions.

2. The 1994 National Research Council Report *Ranking Hazardous-Waste Sites for Remedial Action* (NRC, 1994b) called for a unified national process of hazardous-waste site ranking to replace the current multiple approaches. In summarizing the report, the committee chair, Perry L. McCarty, said that "a single national process could provide a better basis for decisions about

priority setting, how much cleanup or containment should be undertaken at each site, and when.'' Any well-defined and substantiated process could assist EM in making such decisions within the Department complex, although admittedly, challenges will remain. EM should play a leadership role in developing a unified national process, but the implementation of such a procedure should not delay its own decision-making. Having said this, the subcommittee believes that many decisions, such as how much cleanup or containment should be undertaken at each site, should be the subject of interactive communications with the local stakeholders and regulators and consider site-specific information.

Issue: Unwieldy and irrelevant Department procedures often hamper potentially cost-effective and timely cleanup.

For example, samples collected during cleanup of a non-nuclear chemical spill at a nuclear production facility could not be shipped to an outside laboratory that did not have Nuclear Regulatory Commission licensing to handle uranium, even after measurements showed that the soil was not radioactive.

Recommendations:

1. More flexibility is warranted in the adoption of internal safety procedures that properly address the risks of particular operations and do not require use of ''one size fits all'' procedures that were designed for more-hazardous conditions.
2. The Department of Energy has correctly undertaken an extensive review of its internal regulatory orders; this review should continue. Similarly, the Secretary's establishment of the Advisory Committee on External Regulation of Department of Energy Nuclear Safety was an excellent step, and the findings of this group should be closely scrutinized by the administration and Congress.

Issue: The Department of Energy needs a sound, credible base of scientific and technical information.

Integration of science, engineering, and health in the implementation of the EM Program depends on the availability of scientific and technical information. Considerable attention has been paid to the need for more-complete, higher-quality, and independent scientific and technical information in other subcommittees' reports and in many reviews of the EM Program conducted since its inception in 1989 (NRC, 1994; OTA, 1991). The Department of Energy has attempted to respond by increasing the independence and credibility of, for example, radiation-related health research and risk assessment. In both of these areas, however, further improvements are needed. An example of this kind of an effort is the creation of the Consortium on

Risk Evaluation with Stakeholder Participation (CRESP), which resulted from recommendations of an earlier National Research Council report (NRC, 1994b), and has so far been successful.

Responsibility, including funding, for research on the health effects of operations in the nuclear weapons complex was held by the Department and its predecessor agencies until December 1990, when Secretary of Energy James Watkins signed a Memorandum of Understanding (MOU) with the Department of Health and Human Services (DHHS). That MOU transferred much of the responsibility for radiation-related health research to the DHHS and was widely hailed as an important step toward improving the quality and credibility of this research.

The importance of this effort to the EM Program is primarily that (1) providing independent answers to many questions about the consequences of past operations through dose-reconstruction projects, worker-health studies, and other health research is necessary to address public concerns, and (2) information about the extent of contamination, pathways, health effects, and other factors gleaned through these studies will become part of the information base on which future EM decisions rest.

Successful conduct of the research agenda depends on DOE funding and cooperation. Through the MOU cited above, DOE requests funds for studies and then transfers the funds to DHHS. DOE remains responsible for collecting most of the data used in the health research. Continuity of funding has been hindered by restraints on DOE: During the summer of 1995 when DOE responded to proposed cuts in its FY 1996 budget by substantially reducing the amount of money that it proposed to transfer. In response, DHHS put a several-month hold on much of the research program while it attempted to secure funding commitments from DOE. The existing MOU expires in December 1995, and details of an extension are being worked out.

Regarding risk assessment, after publication of the National Research Council report *Building Consensus Through Risk Assessment and Management of the Department of Energy's Environmental Remediation Program* (NRC, 1994a), DOE expanded its efforts to involve independent scientists from universities and private industry in efforts to evaluate risks within the EM Program. The two principal initial methods selected by DOE were a grant to the Consortium for Environmental Risk Evaluation, led by Tulane University and Xavier University, and the request for assistance through publication of a Notice of Program Interest, which resulted in an award to the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) and four additional, smaller and shorter-term awards (UNLV, ASI, Cadmus, Phoenix). CRESP is mandated to lead the coordination effort among these awardees. Both methods reveal weaknesses in the EM Program's study of risk, such as data gaps, inconsistencies, and difficulties in comparing risks across programs (e.g., environmental remediation and nuclear-materials stabilization). Addressing those weaknesses will not be a simple or quick task.

Recommendation:

DOE should continue efforts to improve the independence, quality, and credibility of its scientific and technical information. That can be aided by providing greater assurance that DHHS will be able to continue to direct the radiation-related health research agenda by extending the MOU with provisions that try to guarantee stable funding. It can also be helped by further involvement of the public and independent scientists in reviews of risk and other information.

INCENTIVES AND DISINCENTIVES

Issue: Incentives for good performance by the Department are weak.

The internal operations of and the effectiveness of the integration of science and engineering into the EM Program are hampered by conflicting incentives that are unwritten but understood by employees. For instance, employees are instructed by their superiors that projects need to be completed within definite periods, but their experience tells them that a finished project can result in decreased funding for the program. Therefore, employees might try to ensure the survival of the program by being lax about deadlines. Their understanding of the political appointment process also can cause employees to ignore the chain of command because their civil service loyalties are more important for ensuring employment longevity. Such phenomena are generally parts of the culture of all organizations. However, it is necessary for the culture to support the stated goals of an organization to avoid employees' conflicting incentives that undermine management objectives.

Indeed, to the extent that budgets are allocated according to the extent and seriousness of the environmental problems faced by a site, in a perverse way liabilities become an asset. Likewise, with budgets tied to continuing containment and remediation processes, there is not as strong an incentive to complete projects as might be desired.

The poor incentive structure within the Department carried over to its major contracts until very recently. The Department of Energy is to be congratulated for moving toward performance-based contracts whenever it can, although additional measures will be needed to spur efficiency and to reward success, for both projects and individuals.

Recommendation:

Disincentives within the EM Program should be identified and eliminated so that EM goals and objectives can be reached.

Issue: Incentives for civil-service employees are inadequate.

Many people believe that civil-service regulations prohibit promotions without the addition of supervisory responsibilities, make it difficult to remove employees from positions for poor performance, and do not adequately reward employees for good performance.

It is possible to create a civil-service program that provides more incentives for good performance. Pilot programs of up to 5 years can be initiated by government agencies or units within the government. The National Institute for Standards and Technology had trouble in recruiting new scientists several years ago. It prepared and implemented the Personnel Demonstration Program to remove strict civil-service levels, offered some incentives, and was able to compete with industry for new employees. EM could pilot test a program that explores a different promotion, reward, and firing system. It could be modeled after successful industry and utility models. For example, in Allied Signal's Functional Excellence Review, employees within the bottom 5% for two appraisals are terminated. Employees performing well are reviewed on a regular basis and attempts are made to increase their responsibilities and mobility.

Recommendation:

EM should propose to the Office of Personnel Management and implement a pilot promotion, reward, and firing system.

Issue: New contracting methods will require a new structure.

Most major contracts in the EM Program have had the traditional Department cost-plus format. To its credit, DOE is implementing performance-based contracts. Well-defined, carefully negotiated performance-based contracts can confidently be expected to be much more cost-effective than cost-plus contracts.

Recommendations:

1. The movement toward performance-based contracts, rather than cost-plus contracts, is to be encouraged. However, as the Department moves toward performance-based contracting, lines of authority in the field will become further blurred between the Assistant Secretary for EM and the Associate Deputy Secretary for Field Management, compared with the previous practice of contracting for work on a cost-reimbursal basis. Responsibility for EM contracts let by DOE should reside fully within the EM Program. That would ensure closure of the open management loop described above in the Management Structure section. Experience shows that control under one line of management of all aspects of an operating contract for its duration is much more cost-effective than administration of contracts by multiple parallel lines of management. Using performance-based contracts should

require fewer Department of Energy personnel during the operating phase than are now employed.

2. Prior performance should be a key element in new contract awards.

Issue: EM must create incentives for contractors.

Recommendations:

1. The Department of Energy should become a leader in using incentives to motivate its constituent elements. It should consider the early implementation of the Government Performance and Results Act to emphasize performance metrics focused on outcomes and results.

2. The internal budgeting process and its administration should be revamped to reward site contractors that complete projects early and well. Where feasible, full funding of projects at their start should be considered as a reward for good performance (rather than basing budgets on estimated expenditures for the next fiscal year). Other examples of incentives may be to allow site contractors to retain at least some of whatever savings they achieve. Also, rewarding high-performing sites with new high-priority projects, rather than reducing funding upon successful completion of a project in a timely and cost-effective fashion, might increase productivity.

Integration of Science and Technology into the EM Program

Science and technology play a key role in virtually all the activities of EM. They help to determine priorities for site cleanup by providing the basis for sound risk assessments, provide the tools for achieving remediation goals, and provide the scientific rationale that reassures stakeholders that the priorities and actions of the Department are in their best interest. It is critical that the management structure of the Department be designed to identify and gain access to available technology in a timely and cost-effective fashion. The subcommittee believes that some specific advice on the management of technology development and the scientific research supporting the EM Program is in order.

For EM problems that lack good solutions, EM needs an effective way to bring its resources to bear by developing technologies. Good solutions must also be affordable relative to budget limits, and cost reduction should be an important criteria in new technology development. EM must also ensure that the technologies that have been developed are used and implemented effectively.

Issue: Scientific research and technology development for the EM Program must be tightly linked to the goals of those engaged in remediation and other waste and environmental management activities.

In the past, managers responsible for addressing unique problems have not had the authority to specify and acquire necessary technology rapidly, and managers responsible for handling common challenges have not had a forum to share resources and expertise fully. The current effort to remedy those situations through the formation of five ''Focus Areas''—contaminant plume containment and remediation; mixed waste characterization, treatment, and disposal; high-level waste tank remediation; landfill stabilization; and decontamination and decommissioning—to address the most pressing problems is laudable. The focus group structure uses an implementation team for each subject to recommend the allocation of resources and to carry out research and development activities. Each team includes Department field representatives, stakeholders, regulators, and, most important, technology users.

Recommendation:

The focus groups or any future organizational entities designed to bring users of science and technology closer to researchers and technology developers should have the ability to influence strongly the allocation of funds for EM research and technology development. That would align the budget more closely to the needs of field managers charged with execution of program activities to ensure that site-specific problems are solved.

Issue: The new Office of Science and Technology (OST) can contribute greatly to the accomplishment of EM goals, as can the DOE's Office of Energy Research (OER).

Basic research might produce novel and cost-effective EM solutions.

Recommendation:

The Assistant Secretary for EM should continue to work with the heads of OST and OER to identify technologies and longer-term research for solving EM problems in a holistic fashion. We applaud current efforts of OST to set aside a portion of its R&D budget for the use of OER for exploratory basic research.

Issue: Researchers and technology developers must not only be closely linked with the users of their work, but also be part of an overall systems approach to EM.

Some processes and technologies that might adequately resolve a ''crisis of the moment'' might make remediation actions in the future far more difficult to implement. For example, in-situ vitrification of wastes could make further waste-reduction efforts more complex, and removal of liquids from buried tanks could make later slurrying of sediments more difficult.

Recommendation:

All technical solutions should be evaluated in the light of further action that might be warranted at the site and in the context of a systems approach to the achievement of the Department's overall objectives.

Lessons from Industrial Environmental Management Programs

Progress in environmental management has been achieved by industrial corporations, as well as federal agencies. Some federal agencies are now comparing their processes for achieving environmental goals with those of industry, using, for example, benchmarking. To determine ''best practices'' and define ''conduct of business,'' several industrial models were examined at the subcommittee's workshop.

Issue: Best business practices are not always being applied to the EM Program.

The EM Program has identified places where the effectiveness of its efforts could be improved by the use of management practices developed and used in the private sector. The subcommittee applauds that approach, and it is a useful and appropriate course for the Department and the EM Program in general to follow to ensure that science, technology, and engineering are integrated into its goals for protecting human health and the environment. In particular, the Department is beginning to use performance-based contracting and is even considering complete privatization of waste-remediation processes and technologies.

Recommendation:

In general, the subcommittee strongly supports these efforts. Fully implement best business practices to achieve substantial cost, schedule, and technologic benefits.

Issue: Industry manages its contracts intensively; the Department seems ambivalent about whether it is a "customer" or a "manager."

Some of the comments of EM managers who spoke to the subcommittee indicated that the Department must focus on becoming a better customer of services provided by its contractors or other external entities, rather than on managing the process. The belief that there is a choice is probably naive. It is more accurate to say that the EM Program needs to shift its emphasis away from micromanagement and toward negotiation and management of performance-based contracts that hold contractors accountable for their performance, not their process.

Recommendations:

1. The Department should be an informed consumer. Contractors should be selected with assurance that the best people will be assigned, that contacts and line-of-command are clear, and that negotiated prices are fair to the government and to the contractor.

2. Contracts should be carefully written with milestones that are appropriately selected at key points in the effort, and the Department should be vigilant to ensure that interventions between the milestones are kept to a minimum to prevent cost overruns.

Issue: Some constraints that industry does not face will continue to apply to the government.

The application of private-sector models to public-sector mandates is limited. For instance, if privatization as it is being considered is adopted by EM for portions of the Hanford remediation projects, the financial markets might be unwilling to shift the magnitude of risk involved to the private sector. That could mean that there would be no private-sector bidders to EM to take on the privatized program. If there are no bidders, smaller increments of the task—such as design, construction, or operation—should be put out for bids. Some tasks for privatization might have to be fully government financed or be the recipient of loan guarantees. Furthermore, even if the financial markets are willing to fund these undertakings, the public might challenge the privatized entities' solutions to remediation problems and hamper or stop implementation.

As stated earlier, the Department needs to learn to be a wise contract manager and not micromanage. However, the subcommittee recognizes that the Department will have to continue to take an active position to involve the public and respond to community concerns.

Recommendations:

1. In general, the Department's EM Program should use private-sector models and privatization to meet its objective. However, the models must

be carefully adapted to suit the public-sector mandates. For instance, if privatization is selected by the EM Program to accomplish its goals, the Department must recognize that it might have to supply mechanisms to encourage privatization, for example, guaranteeing in part a stream of revenue or permitting non-DOE customers to use the services of the selected contractor in order to obtain bidders.

2. The EM Program might have to create mechanisms to be responsive to the public, regardless of contractual relationships. That does not have to lead to micromanagement; it might require clearer performance standards or different contractual terms that do not depend on normal contractual remedies for breach of contract.

Issue: Industry is motivated to have an efficient cleanup operation.

Cleanup operations lie outside industries' core business and are paid for from the profits of that business. Therefore, their programs are designed to be very cost-effective. For example, entire technology strategies have been designed to minimize costs and risks at industrial sites by employing conventional technologies, ex situ processes, in situ processes, and natural restoration. Incentives can be offered to work units that perform effectively and efficiently. It can be argued that the EM Program, principally in its cleanup business, might not have incentives to be out of business quickly and efficiently.

Recommendation:

The government should develop a system to reward effective completion of cleanup projects.

Issue: Industry relies on multifunctional teams to manage cleanup projects.

Teams for projects can supplement the normal organizational structure. In industry, input by a multifunctional team—consisting of a technical project leader, a lawyer, a finance manager, a corporate researcher, government relations personnel, and real-estate and construction personnel—starts at the beginning of a project and continues through completion, with the leadership of the team and its composition changing as needs change. Teams, in many industries, are strongly supported by corporate leadership. Teams are usually most effective if there has been training throughout the organization in the operation and use of teams. The Department has been training some teams, but it is not clear at what level they are being used and whether they are multifunctional.

Recommendation:

EM should establish and train multifunctional teams for appropriate projects and empower them to manage the cleanup process. Clear lines of authority and responsibility must be established and maintained for effective team operations.

Integration of Science and Technology into the Community-Relations Process

The Department has made public, or stakeholder, involvement a high priority for the EM Program. Indeed, improving relations with people concerned about environmental activities at Department sites is one of Assistant Secretary Grumbly's six goals for the program. The quantity of available information and the opportunities for public involvement have increased substantially in recent years to meet that goal. In addition, the Department of Energy has put increased emphasis on incorporation of public involvement in the duties of program and project managers.

Public involvement is still evolving, and many of the participants—among the Department and its contractors, as well as within concerned and affected communities—continue to learn and adapt to the changes. One activity in which substantial improvements are needed is the integration of scientific and technical information.

Issue: The Department of Energy needs to communicate information more effectively.

Even high-quality scientific and technical information is of only limited value in EM decision-making if it is not understood and accepted by the Department of Energy's stakeholders. That is because the Department operates in a political environment in which citizen support is essential to obtain funding and, in many cases, to avoid costly and protracted litigation or similar consequences. Moreover, the Department's openness policy and requirements by many environmental laws compel the Department to make the information on which its decisions are based available for public scrutiny.

In many instances, the Department has failed to communicate the scientific and technical basis of important decisions. An example is a 1991 decision to build an incinerator at the Savannah River Site in South Carolina. The public documents initially prepared for the facility used outdated information on waste generation at the site and did not thoroughly discuss issues associated with the incineration of off-site waste. Both those failings attracted public concern and had to be re-addressed by the Department.

The reasons for the Department's lack of successful communication are varied. In some instances, the Department did not internally understand the project and so was unable to explain the rationale clearly. In others, the Department had the technical information but lacked the communication channels to work effectively with the public.

In other cases, however, the Department has been more successful—often with substantial assistance from skilled, independent facilitators or technical experts. A frequently praised example is the evaluation of land-use options at the Fernald Site in Ohio. Citizens reviewed levels of contamination, remediation alternatives, and other factors and came to agreement with the Department about remediation goals. Another example is the storage of special nuclear materials at the Rocky Flats Environmental Technology Site in Colorado; the Department at first assumed that citizens would object to a new facility but, after describing the technical issues, discovered that citizens were open to the idea.

Recommendations:

1. The Department of Energy should improve its own abilities, and those of its contractors, to communicate scientific and technical information. The various community-relations personnel in the Department system, as well as program and project managers, need the tools to communicate effectively with a variety of audiences and their understanding of program-wide and complex-wide issues needs to be sufficient to ensure that they can discuss matters beyond their immediate concern or expertise.

2. The Department of Energy should also make better use of outside resources in communicating scientific and technical information. That can include working with independent professionals. Another component of the effort can be providing funds to concerned community groups so that they can develop their own technical understanding and expertise. Indeed, the Department has already provided some such grants. It should, however, further define the selection and performance criteria for the awards. The experience of other federal agencies might be helpful in this regard.

Issue: It is important to meld public concerns and scientific and technical information into decision-making.

Many of the decisions faced by the EM Program cannot be made strictly within a box created by scientific and technical information. Practical factors compel consideration of cost and other resource limitations (including sometimes those of regulatory agencies). Political factors that influence decisions include socioeconomic impacts, cultural demands, such policy issues as nonproliferation, and public concerns.

A decision that is not supported by sound scientific and technical understanding might not succeed or might result in unnecessary costs or risks. The challenge for EM managers is to bring together a variety of factors into a well-balanced, implementable decision. That is inherently a dynamic process in which the elements of individual decisions will vary with the nature of the activity (which can range from groundwater remediation to nuclear-material stabilization) and with local concerns.

Recommendation:

The Department of Energy should seek to improve understanding and communication of the role of scientific and technical information relative to other factors in its decision-making. It should identify the role of public participation in the decision-making process. To be useful, public participation should be designed to address well-defined issues, occur early enough to influence outcomes, and have clear mechanisms for considering and responding to public comments.

References

Alternative Futures for the Department of Energy National Laboratories, prepared by the Secretary of Energy Advisory Board. February 1995. The report, also know as the Galvin Task Force, examines the role of Department of Energy National Laboratories and reviews the Department of Energy Environmental Management Program. Strongly critical of its activities, the report recommends changes in governance, economic role, science and engineering role, and environmental role. One of the most important challenges facing the Department and its laboratories to achieve greater integration of its various applied and fundamental energy R&D programs. Many fields of research and technology development could make up an appropriate energy agenda for the laboratories.

Benchmarking for Change: A Workshop Resulting from the RI/FS Benchmarking Study, February 1995. Organized by the Department of Energy Office of Environmental Restoration. The workshop summaries are not yet available, but copies of the presentations have been compiled. The workshop, chaired by Ned Larson (EM-45) focused on the highlights of the Remedial Investigation/Feasibility Study (RI/FS) Benchmarking study. Such issues as partnerships, project management, procurement, and pilot projects were discussed in breakout sessions.

Building Consensus Through Risk Assessment and Risk Management in the Department of Energy Environmental Remediation Program, NRC (National Research Council). 1994a. National Academy Press, Washington, D.C.

Cleaning Up the Department of Energy's Nuclear Weapons Complex, Congress of the United States, Congressional Budget Office, May 1994. The report outlines the Department's environmental goals and its cleanup program, including such policy issues as understanding risks, weighing costs and benefits, setting priorities, and investing in the development of technologies. The report acknowledges that the Department's cleanup program must address a problem that was created and largely ignored over the last 50 years. The department is faced with doing so during an especially tight budget climate. CBO recommends that understanding of risks and costs better would be the best way to determine priorities for allocating the scarce cleanup funds. It also recommends investing more heavily in technology development, delaying technically difficult projects, and cutting overhead costs to improve the efficiency of cleanup efforts. In addition, new management systems might help the Department of Energy and Congress track the performance of cleanup projects.

Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production, OTA (U.S. Congress, Office of Technology Assessment), 1991. OTA-O484. U.S. Government Printing Office, Washington, D.C.

Environmental Management 1995: Progress and Plans of the Environmental Management Program, February 1995, US Department of Energy, Office of Environmental Management. The report identifies 1994 accomplishments in the topics established as goals of the Environmental Management Program:

- Eliminate and manage urgent risks in the system.
- Emphasize health and safety of workers and the public.
- Establish a system that is managerially and financially in control.
- Demonstrate tangible results.
- Focus technology development on overcoming obstacles to progress.
- Establish a stronger partnership between the Department and its stakeholders.

National programs and site summaries provide an overview of the activities in environmental regulation, waste management, environmental restoration, technology development, nuclear-material and -facilities stabilization, safety and health, risk management and priority-setting, and public accountability and outreach.

Hanford Integrated Planning Process: 1993 Hanford Site Specific Science and Technology Plan. Pacific Northwest Laboratory. 1993. U.S. Department of Energy Richland Operations Office Report DOE/RL-93-38. Richland, WA.

Health and Ecological Risks at the US Department of Energy's Nuclear Weapons Complex: A Qualitative Evaluation. Consortium for Environment Risk Evaluation (A Tulane/Xavier Program for the US Department of Energy). CERE Interim Risk Report. March 1995.

Independent Technical Review of the Brookhaven National Laboratory Environmental Restoration Program. June 1995. US Department of Energy, Chicago Operations Office, chartered an Independent technical review team to assess the Brookhaven National Laboratory (BNL) Environmental Restoration Program on the basis of commercial business practices and metrics and to recommend improvements if commercial and BNL practices, processes, or performance differed substantially. The overriding environmental-restoration goal in the commercial realm was defined to protect human health and the environment within the legal framework and within costs and schedules while providing immediate, open communication with interested and affected parties. In industry, protecting the ability to make money was considered paramount, so liability was often reduced quickly by investments in environmental activities. The team provided recommendations for business-process improvements and commercial environmental-restoration strategies.

Independent Technical Review of Environmental Restoration at Los Alamos National Laboratory, January 1995. Conducted by the Environmental Management Program at the Los Alamos National Laboratory. "To assess the barriers facing the program and develop approaches to ensure restoration success," the independent technical review team developed commercial standards by which to compare the restoration activities at Los Alamos. Benchmarking analysis included costs of operation.

Independent Technical Review of the Rocky Flats Program, June 1995. US Department of Energy, Office of Nuclear Material and Facility Stabilization, requested an independent technical review of the FY 1995 liability reduction and building baseline activities at the Rocky Flats Environmental Technology Site. To achieve liability reduction and improve efficiency, it was recommended that the DOE Rocky Flats Field Office senior management translate the strategic plan into a work logic based on budget and contractor performance measures. The change from a manage and operate (M&O) contractor to a performance based integrating contractor (PBIC) was thought to provide a unique opportunity to establish a new working relationship based on commercial business-like conduct and cleanup.

Management Changes Needed to Expand Use of Innovative Cleanup Technologies, US General Accounting Office, August 1994. The report identifies internal and external barriers to the use of new environmental technologies. It notes that although the Department has spent much to develop waste-cleanup technologies, little new technology is being implemented in the agency's cleanup actions. Part of the agency's problem, the report notes, is that the Department does not have a well-coordinated and fully integrated technology-development program. The Department's plan to restructure its technology-development programs is a step toward alleviating the problem. Field offices will also consider new and innovative technologies more seriously.

Organization and Staffing Review, January 1994. Office of Assistant Secretary for Environmental Restoration and Waste Management. At the request of the Assistant Secretary of Environmental Restoration and Waste Management, the Office of the Assistant Secretary for Human Resources and Administration led a review of program-related organizations, their staffing, and the associated environmental-management functions at headquarters and field locations. The review provides a perspective on how environmental-management programs are being administered by federal personnel and what issues attended their performance.

Project Performance Metrics Study, November 1993. Prepared by Independent Project Analysis, Inc., Reston, Virginia. The report was commissioned by the Office of Environmental Restoration and Waste Management (EM) of the US Department of Energy to asses the status of the EM project systems and to provide a baseline for measuring improvements against industry and other organizations. The report compares key measures of the environmental restoration and waste management project systems with the Independent Project Analysis proprietary industry Environmental Remediation and Capital Projects databases. The study establishes a comparison with industry and other organizations with respect to cost, schedule performance, project duration, and management turnover. Conclusions are drawn about the competitiveness of the project systems, and recommendations identify opportunities for improvement.

Ranking Hazardous-Waste Sites for Remedial Action, NRC (National Research Council). 1994b. National Academy Press, Washington, D.C.

Report of the Defense Science Board Task Force on Environmental Security, Department of Defense, Office of the Undersecretary of Defense, Acquisition and Technology, April 1995. The DOD environmental-remediation effort is a multibillion-dollar endeavor. Among the possibilities for improvement that the report addresses is acceleration of environmental-technology development and deployment. It notes that many existing technologies offer substantial potential for risk or cost reduction that is not being realized, in part because of regulatory barriers. It identifies the barriers to deployment of new environmental technology as the worst bottleneck and expresses concern that with today's shrinking environmental budgets sufficient environmental science and technology investments that could reduce future costs will not be made. The group made several recommendations for accelerating technology development and deployment, including devoting an additional $150 million/year for accelerated environmental-technology demonstration and verification, clarifying assignment of responsibility, developing a set of incentives for federal site directors to use new technologies, and expanding cooperation among agencies and with industry.

Risks and the Risk Debate: Searching for Common Ground, The First Steps, June 1995. US Department of Energy, Office of Environmental Management. The Department has taken preliminary steps in the creation of a department-wide uniform process to evaluate risks to the environment and to health. Ultimately, this process should be capable of identifying the location and situations that pose the most serious risks across the nation to workers, the public, and the environment. Imminent risks to the environment and health should be of highest priority for action. For non-imminent risks, risk assessment should be used to identify the benefits of risk reduction as part of overall cost-benefit analyses, which should form the basis for further priority-setting and the timely resolution of contamination problems that must be addressed as required by law or compliance agreements.

Technology Needs Crosswalk Report, First Edition, Abridged Version, Chem-Nuclear Geotech, Inc. 1993. U.S. Department of Energy Albuquerque Field Office Report DOE/ID/12584-117 Ed. 1, Grand Junction, CO.

Train Wreck Along the River of Money—An Evaluation of the Hanford Cleanup, 1994. Written at the request of the US Senate Committee on Energy and Natural Resources, the report evaluates the cleanup of the Hanford Nuclear Reservation in Washington state. It critically examines such issues as cost of cleanup, management of programs, regulatory compliance, assignment of responsibilities, and future land use.

Appendix A
Charge to the Committee

U.S. Department of Energy
Washington, DC 20585

January 11, 1995
[Receipt]

Dr. Bruce Alberts
President, National Academy of Sciences
2101 Constitution Avenue, NW
Washington, DC 20418

Dear Dr. Alberts:

The National Academy of Sciences has a proven track record in providing the Department of Energy with scientific analyses critical to the success of the Environmental Management program. Faced with constrained budgets and the need to develop a system that works better and costs less, the Department once again would be aided by an analysis by the Academy. It is recognized that the cleanup problems now facing the Department and the Nation require a total re-engineering of existing systems and a thorough examination of the scientific, engineering, and institutional barriers to achieving a more cost-effective stewardship of the Nation's resources. This examination should be far more comprehensive than past analyses, which have involved subject experts in narrow fields.

Given the enormity of the Environmental Management Program, it is envisioned that a comprehensive evaluation will be more successful if it is focused around a few broad areas of major concern. Suggested topics include priority setting, timing and staging of activities, technology development, management and organizational systems, and regulatory measures.

Discussion on these and other issues would start with a series of public fora, which would then lead to an intense summer study. The public fora would provide options and observations for the summer study, while allowing for educational exchanges between stakeholders, scientists and decision makers. The summer study, attended by nationally recognized experts, would help frame options and factors for decision making. I would like to see the results of the study by December 1, 1995.

I have asked Admiral Richard Guimond and Dr. Carol Henry to be the principal Department points of contact for framing the specific questions and context in which the Academy reviewers would perform their analysis. This work will be performed under cooperative agreement #DE-AC01-94EW54069. I look forward to working with the Academy to obtain the scientific and engineering community's views on these very important issues.

Sincerely,

Thomas P. Grumbly
Assistant Secretary for
Environmental Management

Enclosure

PROPOSED NATIONAL ACADEMY OF SCIENCE FORA

The five proposed fora topics encompass major issues that the Environmental Management program is likely to encounter in the next several years. The Department will work with the Academy to further define the content and range of issues to be evaluated within each fora.

Priority Setting

The Priority Setting forum will examine the process of prioritizing Environmental Management activities, and how the process incorporates societal values, costs, current regulations, and risks to the environment, public health, and worker safety.

Timing and Staging of Activities

The Timing and Staging forum will examine how the Environmental Management program can schedule technology development and remediation/ restoration efforts such that cost savings are maximized and risks to the environment, public, and workers are minimized.

Technology

The Technology forum will examine all aspects of how technology can best be developed and utilized to aid the federal remediation process.

Management and Organizational Systems

The Management and Organizational Systems forum will examine the management and organizational systems which are most likely to achieve Environmental Management program goals.

Regulatory Measures

The Regulatory Measures forum will examine how the performance of the Environmental Management program could be improved through regulatory measures such as new statues, revised statues, and revised regulatory agreements.

Appendix B
Workshop Agendas

NATIONAL RESEARCH COUNCIL

COMMITTEE TO EVALUATE THE SCIENCE, ENGINEERING, AND HEALTH BASIS OF THE DOE'S ENVIRONMENTAL MANAGEMENT PROGRAM

Evaluation of Regulatory Measures Workshop

National Academy of Sciences Building
2101 Constitution Avenue, NW
Washington, DC 20418

June 19–20, 1995

AGENDA

Monday, June 19

Workshop—Plenary Session—Auditorium

4:00 pm **Welcome**
E. William Colglazier, Executive Officer, National Research Council
Don Clay, Workshop Chair

4:10 **Carol J. Henry**, Science and Policy Director, Office of Integrated Risk Management, Department of Energy (DOE)

Ellen Livingston-Behan, Acting Executive Officer, Office of Environmental Management, Department of Energy (DOE)

4:50 Question and Answer

5:30 Recess

Tuesday, June 20

Workshop—Plenary Session—Auditorium

9:00 am Welcome
Don Clay, Workshop Chair

Panel 1: Views from Office of Environment, Safety, and Health of Department of Energy

9:10	**Andrew Lawrence**, Director, Compliance Assessment Division, Office of Environmental Policy and Assistance, DOE/ESH
9:25	**Joseph Fitzgerald, Jr.**, Deputy Assistant Secretary for Worker Health and Safety, Office of Environment, Safety and Health, Department of Energy
9:40	Questions & Answers; Issue Identification

Panel 2: Views from the Other Federal Agencies

9:50	**Elizabeth Cotsworth**, Deputy Director, Office of Solid Waste, Environmental Protection Agency
10:05	**Camilla Warren**, Chief of DOE Remedial Section, Federal Facilities Branch, Environmental Protection Agency, Region IV
10:20	**John Austin**, Chief, Performance Assessment and Hydrology Branch, Division of Waste Management, Nuclear Regulatory Commission
10:35	Questions & Answers; Issue Identification
10:45	Break—Great Hall

Panel 3: Views from DOE Sites and Outside of the Federal Government

11:00	**Sam Goodhope**, Special Assistant Attorney General, Office of the Attorney General, State of Texas
11:15	**Joseph Nagel**, Nagel Environmental Consulting (former Director, Department of Environmental Quality for the State of Idaho)
11:30	**Don Macdonald**, Executive Assistant to the Manager of the Idaho Operations Office, Department of Energy
11:45	**Louis Bogar**, Independent Consultant (former Vice-President, Westinghouse Materials Company of Ohio)

12:00 pm **Adam Babich**, Editor-in-chief of *The Environmental Law Reporter*, Environmental Law Institute

12:15 Question & Answers; Issue Identification

12:30 Break

Board Room

Roundtable Discussion: committee, speakers, invited discussants

1:30 Overview
Don Clay, Workshop Chair

Roundtable discussants (in addition to committee members and morning speakers):

Elmer Akin, Chief, Office of Health Assessment, Waste Management Division, Environmental Protection Agency, Region IV

Lokesh Chaturvedi, Deputy Director, Environmental Evaluation Group of the New Mexico Institute of Mining and Technology

Tom Isaacs, Executive Director, Advisory Committee on External Regulation of Department of Energy Nuclear Safety

David O'Very, Attorney Advisor/Special Assistant to the Director, Office of Radiation and Indoor Air

Suzanne Rudzinski, Director of the Office of Policy Analysis, Office of Environmental Management, Department of Energy

Milton Russell, Director, Joint Institute for Energy and Environment, Professor of Economics, University of Tennessee

4:25 Closing: **Don Clay**

4:30 Workshop ends

NATIONAL RESEARCH COUNCIL

COMMITTEE TO EVALUATE THE SCIENCE, ENGINEERING, AND HEALTH BASIS OF THE DOE'S ENVIRONMENTAL MANAGEMENT PROGRAM

Priority Setting, Timing & Staging of Environmental Management Activities Workshop

National Academy of Sciences Building
2101 Constitution Avenue, NW
Washington, DC 20418

June 26–27, 1995

AGENDA

Monday, June 26

Lecture Room

Workshop—Plenary Session

4:00 pm	Welcome **E. William Colglazier**, Executive Officer, National Research Council **Toby Clark**, Committee Chair Executive Director, Clean Sites, Inc.
4:10	**Carol J. Henry**, Science and Policy Director, Office of Integrated Risk Management, Department of Energy (DOE)
4:50	Questions & Answers
5:30	Recess

Tuesday, June 27

Lecture Room

Workshop—Plenary Session

9:00 am	Welcome: **Toby Clark**, Committee Chair
9:15	**Panel 1: View from the Field**

Douglas L. Weaver, Independent Review Program Manager, Sandia National Laboratories

Bob Anderson, Project Leader, Prioritization, Environmental Health and Safety Division, Los Alamos National Laboratory

Curtis Travis, Director, Center for Risk Management, Oak Ridge National Laboratory

10:15 Questions & Answers; Issue Identification

10:45 Break

11:00 **Panel 2: View from the Outside**

John Applegate, Professor, College of Law, University of Cincinnati; and Chair, Fernald Citizens Task Force

Susan Wiltshire, Vice President, JK Research Associates

Toby Michelena, Coordinator of Tank Waste Remediation Systems, Nuclear Waste Program, Washington State Department of Ecology

Lee Merkhofer, Principal, Applied Decision Analysis, Inc.

12:00 pm Questions & Answers; Issue Identification

12:30 Break

Lecture Room

Roundtable Discussion: committee, speakers, invited discussants

1:30 Overview: **Toby Clark**, Committee Chair

Roundtable discussants (in addition to committee members and morning speakers)

Brian Costner, Director, Energy Research Foundation

Julie D'Ambrosia, Program Manager, EcoTech Associates, Inc.

Robert N. Ferguson, Oversight Administrator, Idaho National Engineering Laboratory, State of Idaho

Mark Gilbertson, Program Director, Office of Integrated Risk Management, Department of Energy (DOE)

4:25 Closing: **Toby Clark**, Committee Chair

4:30 Workshop ends

NATIONAL RESEARCH COUNCIL

COMMITTEE TO EVALUATE THE SCIENCE, ENGINEERING, AND HEALTH BASIS OF THE DOE'S ENVIRONMENTAL MANAGEMENT PROGRAM

Workshop on Utilization of Science, Engineering, and Technology in the Environmental Management Program

National Academy of Sciences Building
2101 Constitution Avenue, NW
Washington, DC 20418

July 11–14, 1995

AGENDA

Tuesday, July 11

Workshop—Plenary Session—Auditorium

4:00 pm Welcome
E. William Colglazier, Executive Officer, National Research Council
Frank Parker, Workshop Chair

4:10 **Carol Henry & Mac Lankford**, Department of Energy (DOE)

4:50 Question and answer

5:30 Adjourn to **Auditorium Gallery** for reception

Wednesday, July 12

Workshop—Plenary Session—Lecture Room

9:00 am Welcome
Frank Parker, Workshop Chair

Presentations: Views from the DOE

9:15 **Mac Lankford & Teresa Fryberger**, Department of Energy (DOE)

9:40 **Harry Harmon**, Savannah River

10:05 Questions & answers; Issue identification

10:20 Break—Lecture Room

Presentations: View from the Outside

10:30 **Walter Kovalick**, EPA

10:50 **John Carberry**, DuPont

11:20 **Robert Hightower**, Lockheed Martin Energy Systems

11:40 **Rebecca T. Parkin**, Public Health Considerations in Environmental Cleanup

12:00 pm Question & answers; Issue identification

Workshop—Roundtable—Lecture Room

Roundtable Discussion: committee, workshop participants, and speakers

1:30 Overview: **Frank Parker**, Workshop Chair

Roundtable discussion leaders:

Teresa Fryberger, DOE

Gretchen H. McCabe, Battelle

Pat Whitfield, Environmental Management Consulting

Christopher Nagel, Molten Metal Technology

David Rubenson, Rand Corporation

Toby Clark, Clean Sites

4:25 Closing: **Frank Parker**, Workshop Chair

4:30 Workshop ends

NATIONAL RESEARCH COUNCIL

COMMITTEE TO EVALUATE THE SCIENCE, ENGINEERING, AND HEALTH BASIS OF THE DOE'S ENVIRONMENTAL MANAGEMENT PROGRAM

Subcommittee on Integration of Science, Engineering, and Health in Program Implementation

National Academy of Sciences Building
2101 Constitution Avenue, NW
Washington, DC 20418

August 29–30, 1995

AGENDA

Tuesday, August 29

Lecture Room

Workshop—Plenary Session

4:00 pm Welcome

E. William Colglazier, Executive Officer, National Research Council

Victoria Tschinkel, Workshop Chair
Senior Consultant, Landers and Parsons

4:10 **Rear Admiral Richard J. Guimond**, Principal Deputy Assistant Secretary for Environmental Management, Department of Energy

4:50 Questions & Answers

5:30 Adjourn for day

Wednesday, August 30

Lecture Room

Workshop—Plenary Session

8:30 am Welcome; **Victoria Tschinkel**, Workshop Chair

Panel 1: View from DOE Headquarters

Moderator: **Victoria Tschinkel**

8:35 **Gail Pesyna**, Deputy Assistant Secretary for Management and Finance, Office of Environmental Management, Department of Energy

8:55 **Ken Glozer**, Senior Advisor to the Assistant Secretary for Environmental Management, Department of Energy

9:15 Questions & Answers; Issue Identification

Panel 2: View from the DOE Sites

Moderator: **Brian Costner**, committee member

9:35 **Hank McGuire**, Vice President of Business Development, Scientific Ecology Group, Westinghouse Corporation

9:50 **Philip Thullen,** Program Manager, Independent Technical Review, Environmental Management Program, Red Team Reviews

10:05 **John Applegate**, Chair, Fernald Citizens Task Force

10:20 Questions & Answers; Issue Identification

10:40 Break

Panel 3: Perspectives Outside of DOE

Moderator: **Maxine Savitz**, committee member

10:55 **Philip Palmer**, Senior Environmental Fellow, Dupont Specialty Chemicals Corporate Remediation, E.I. du Pont de Nemours & Company

11:10 **Dan Abramowicz**, Manager, Environmental Laboratory, General Electric Corporate Research and Development

Kevin Holtzclaw, Senior Program Manager, Environmental Remediation Program, General Electric Company

11:30 **Patricia Rivers**, Assistant Deputy Under Secretary of Defense for Environmental Cleanup, Department of Defense

11:45 **Richard Marty**, Senior Engineer Specialist, Jason Associates Corporation

12:00 Questions & Answers; Issue Identification

12:30 Lunch

Lecture Room

1:30 pm Overview: **Victoria Tschinkel**, Workshop Chair

Roundtable Discussion: committee, speakers, discussants

Roundtable Discussants: (*in addition to committee and speakers*)

Doug Weaver, Program Manager, Independent Technical Review

Deborah Bennett, Staff Member, Environmental Management Program, Red Team Reviews

4:25 Closing: **Victoria Tschinkel**, Workshop Chair

4:30 Workshop ends

Appendix C
Biographical Information on Committee Members

BIOGRAPHICAL INFORMATION FOR MEMBERS OF THE SYNTHESIS SUBCOMMITTEE

John F. Ahearne is the Executive Director of Sigma Xi, the Scientific Research Society; Lecturer in Public Policy, Duke University; and Adjunct Scholar, Resources for the Future. He has served as Vice President and Senior Fellow for Resources for the Future; Commissioner and Chairman of the U.S. Nuclear Regulatory Commission; System Analyst for the White House Energy Office; Deputy Assistant Secretary of Energy; and Deputy and Deputy Assistant Secretary of Defense. He received his MS from Cornell University and his MA and PhD from Princeton University.

Andrew P. Caputo is an Attorney with the Natural Resources Defense Council's Nuclear Program. He was previously Associate Attorney and then Project Attorney with the Sierra Club Legal Defense Fund from 1990–93. He received his A.B. in history from Brown University and holds a JD from Yale Law School.

Edwin H. Clark II is President of Clean Sites, Inc., in Alexandria, VA. He is former Secretary of the Delaware Department of Natural Resources and Environmental Control, Vice President of the Conservation Foundation, and Acting Assistant Administrator of the pesticides and toxic substances program in the Environmental Protection Agency. He holds a PhD in applied economics from Princeton University.

Don Clay is President of Don Clay Associates, a public policy consulting firm devoted to solid and hazardous waste issues. From 1989–93 he headed the EPA's Office of Solid Waste and Emergency Response where he implemented many reforms including the Superfund Revitalization Initiative and Accelerated Cleanup Model. Prior to this position, he was Deputy Assistant Administrator of the Office of Air and Radiation, 1986–89; and Director of the Office of Toxic Substances, 1981–86 at the EPA. He holds an MS from Ohio State University.

Douglas M. Costle is Chairman and Distinguished Fellow at the Institute for Sustainable Communities based in Montpelier, Vermont. He is former Administrator of the US EPA, appointed by President Jimmy Carter in 1976 and served until 1981. Mr. Costle is a former Fellow at the Smithsonian's Woodrow Wilson International Center for Scholars; Visiting Scholar at Harvard's School of Public Health; and Adjunct Lecturer at Harvard's John F. Kennedy School of Government. He was Dean of Vermont Law School from 1987–91 and greatly strengthened the program under his tenure. In November 1992, Mr. Costle was appointed to lead the Clinton Transition Team on Energy. He holds a JD from Chicago Law School.

James R. Curtiss is a Partner in the law firm of Winston and Strawn in Washington, DC. He was previously Commissioner of the Nuclear Regulatory Commission, 1988–93. He also served as Associate Counsel for the Senate Committee on Environment and Public Works for the U.S. Senate from 1981–88. From 1979–81, Mr. Curtiss was Staff Attorney in the Regulations Division for the Office of the Executive Legal Director at the Nuclear Regulatory Commission. Mr. Curtiss holds a JD from the University of Nebraska.

Frank L. Parker is Distinguished Professor of Environmental and Water Resources Engineering at Vanderbilt University. Dr. Parker served as Chairman of the Board of Radioactive Waste Management of NAS/NRC and is a member of several environmental advisory committees including the Environmental Management Advisory Board of the Department of Energy. He is a member of the National Academy of Engineering. He received his BS from the Massachusetts Institute of Technology and his PhD in civil engineering from Harvard University.

Victoria J. Tschinkel is Senior Consultant for environmental issues at the law firm of Landers and Parsons in Tallahassee, Florida. From 1981 to 1987, she was Secretary of the Florida Department of Environmental Regulation, serving as the agency's chief administrative and policy officer. Ms. Tschinkel is Chairman of the Advisory Council of the Gas Research Institute and a Fellow of the National Academy of Public Administration. She received her B.S in zoology from the University of California at Berkeley.

John T. Whetten is a Senior Applications Consultant to Motorola in Los Alamos, NM. He was previously Associate Director for Energy and Technology at Los Alamos National Laboratory. Dr. Whetten has many years of experience in research for the U.S. Geological Survey in Seattle; and in university teaching, research and administration at the University of Washington. He holds a PhD in geology from Princeton University.

BIOGRAPHICAL INFORMATION FOR MEMBERS OF THE SUBCOMMITTEE ON THE EVALUATION OF REGULATORY MEASURES

Don Clay is President of Don Clay Associates, a public policy consulting firm devoted to solid and hazardous waste issues. From 1989–93 he headed the EPA's Office of Solid Waste and Emergency Response where he implemented many reforms including the Superfund Revitalization Initiative and Accelerated Cleanup Model. Prior to this position, he was Deputy Assistant Administrator of the Office of Air and Radiation, 1986–89; and Director of the Office of Toxic Substances, 1981–86 at the EPA. He holds an MS from Ohio State University.

Andrew P. Caputo is an Attorney with the Natural Resources Defense Council's Nuclear Program. He was previously Associate Attorney and then Project Attorney with the Sierra Club Legal Defense Fund from 1990–93. He received his A.B. in history from Brown University and holds a JD from Yale Law School.

James R. Curtiss is a Partner in the law firm of Winston and Strawn in Washington, DC. He was previously Commissioner of the Nuclear Regulatory Commission, 1988–93. He also served as Associate Counsel for the Senate Committee on Environment and Public Works for the U.S. Senate from 1981–88. From 1979–81, Mr. Curtiss was Staff Attorney in the Regulations Division for the Office of the Executive Legal Director at the Nuclear Regulatory Commission. Mr. Curtiss holds a JD from the University of Nebraska.

Marshall E. Drummond is President of Eastern Washington University. He has chaired several public advisory groups, including the Hanford Tank Waste Task Force and the Hanford Future Site Use Working Group. He received a doctor of education degree from the University of San Francisco.

Daniel S. Miller is First Assistant Attorney General with the Colorado Department of Law in Denver where he supervises the hazardous-waste and solid-waste unit, representing it on all RCRA, CERCLA, and solid-waste matters. He has expertise in environmental compliance at federal facilities, including Rocky Flats and Rocky Mountain Arsenal. He holds a JD from the University of California, Berkeley.

Bernard J. Reilly is Corporate Counsel for DuPont Legal in the Environment Group where he is responsible for plant permit and compliance issues, corrective actions, and Superfund sites in New Jersey. He is also responsible for the overall management of DuPont's legal involvement in Superfund and its reauthorization. Mr. Reilly holds a BS in engineering from the United States Marine Academy, an MS in mechanical engineering from Brown University, and a JD from the University of Virginia.

Mary Riveland is the Director of the Washington State Department of Ecology, the state's primary environmental agency. Ms. Riveland is also a member of the Environmental Management Advisory Board and the Governor's Task Force on Regulatory Reform, and serves on the executive board of the Environmental Council of the States. She holds a BA in political science from the University of Washington.

BIOGRAPHICAL INFORMATION FOR MEMBERS OF THE SUBCOMMITTEE ON PRIORITY SETTING, TIMING AND STAGING

Edwin H. Clark II is President of Clean Sites, Inc., in Alexandria, VA. He is former Secretary of the Delaware Department of Natural Resources and Environmental Control, Vice President of the Conservation Foundation, and Acting Assistant Administrator of the pesticides and toxic substances program in the Environmental Protection Agency. He holds a PhD in applied economics from Princeton University.

Hugh J. Campbell Jr. is Environmental Manager at DuPont with over 20 years of experience in the environmental field consulting on and managing water, wastewater, solid/hazardous waste, geological engineering, site investigation and remedial action issues. From 1972–87 he did consulting work relating to industrial waste management/control for E.I. du Pont de Nemours and Company. Dr. Campbell holds an MS in sanitary engineering from the University of Maine at Orono, and a PhD in environmental engineering from Purdue University.

Mary R. English is Associate Director of the Energy, Environment, and Resources Center at the University of Tennessee, and a Senior Fellow at its Waste Management and Education Institute. She previously worked in environmental planning for state government and as a consultant. She holds an MS in regional planning from the University of Massachusetts and a PhD in Sociology from the University of Tennessee.

Donald R. Gibson Jr. is Department Manager of the Systems Analysis Department and Acting Lab Manager at TRW's Ballistic Missiles Division in its survivability and engineering laboratory. Prior to these positions he was a design physicist and senior project engineer. Dr. Gibson holds an MS and PhD in nuclear engineering from the University of Illinois.

Robert E. Hazen is Chief of the Bureau of Risk Assessment at the New Jersey Department of Environmental Protection since 1984. He is formerly an Assistant Professor in the Environmental Health Science Program at Hunter College, City University of New York. Dr. Hazen holds an MS from Fairleigh Dickinson University and a PhD in biology and environmental health from New York University.

Thomas Leschine is Associate Professor in the School of Marine Affairs at the University of Washington. He is a former Fellow in Marine Policy and a Policy Associate at the Woods Hole Oceanographic Institute. His major research interest is in the area of environmental decision making as it relates to marine pollution control. Dr. Leschine holds a PhD from the University of Pittsburgh.

Robert H. Neill is Director of the Environmental Evaluation Group in Albuquerque, NM. EEG performs independent evaluations of the health and environmental impacts of the Waste Isolation Pilot Plant, a DOE repository for the disposal of defense transuranic wastes. He was previously a Commissioned Officer in the Bureau of Radiological Health, US Public Health Service for 23 years. Mr. Neill holds an ME from Stevens Institute of Technology and an MS in radiation hygiene from Harvard University.

Lynne M. Preslo is Senior Vice President for Technical Programs at Earth Tech in Berkeley, CA. She is a hydrogeologist and California Registered Geologist with more than 15 years of environmental consulting experience. Ms. Preslo holds a BS in applied earth sciences and an MS in hydrogeology from Stanford University.

Anne E. Smith is Principal and Vice President at Decision Focus, Inc. in Washington, DC. Prior to her current position she has been an independent consultant, an EPA consultant, and an EPA economist. Dr. Smith holds an MA and a PhD in economics, with PhD minor in engineering-economic systems, from Stanford University.

Mervyn L. Tano is General Counsel and Senior Environmental Programs Manager for the Council of Energy Resources Tribes based in Denver, CO. He advises and assists tribes on high-level radioactive-waste issues; legal, administrative, and technical system requirements; and environmental, health, and safety implications. He also advises the DOE and nuclear-negotiation officials on tribal jurisdictional issues related to high-level waste management and transportation. Mr. Tano holds a JD from Brigham Young University.

BIOGRAPHICAL INFORMATION FOR MEMBERS OF THE SUBCOMMITTEE ON UTILIZATION OF SCIENCE, ENGINEERING, AND TECHNOLOGY

Frank L. Parker is Distinguished Professor of Environmental and Water Resources Engineering at Vanderbilt University. Dr. Parker served as Chairman of the Board of Radioactive Waste Management of NAS/NRC and is a member of several environmental advisory committees including the Environmental Management Advisory Board of the Department of Energy. He is a member of the National Academy of Engineering. He received his BS from the Massachusetts Institute of Technology and his PhD in civil engineering from Harvard University.

John F. Ahearne is the Executive Director of Sigma Xi, the Scientific Research Society, and Adjunct Scholar, Resources for the Future. He has served as Vice President and Senior Fellow for Resources for the Future; Commissioner and Chairman of the U.S. Nuclear Regulatory Commission; System Analyst for the White House Energy Office; Deputy Assistant Secretary of Energy; and Deputy and Deputy Assistant Secretary of Defense. He received his MS from Cornell University and his MA and PhD from Princeton University.

Charles B. Andrews is President of S. S. Papadopulos & Associates, and directs projects involving quantitative ground water hydrology. He previously served as senior project hydrologist with Woodward-Clyde Consultants, where he worked on projects that included managing cleanup of Superfund sites. Dr. Andrews holds a PhD in geology from the University of Wisconsin.

Edgar Berkey is President and Co-Founder of the Center for Hazardous Materials Research, and the National Environmental Technology Applications Center, two non-profit environmental organizations in Pittsburgh, PA. Previously, he was founder and President of SynCo Consultants, Inc.; Vice President of Energy Impact Associates, and Manager and Senior Scientist at Westinghouse Research Laboratories. Dr. Berkey holds a PhD in engineering physics from Cornell University, and completed the Executive MBA Program at the University of Pittsburgh.

Harold K. Forsen is Foreign Secretary of the National Academy of Engineering. He is retired Senior Vice President and Director of Bechtel Hanford, Inc. He has been a consultant to many organizations including General Atomics, Oak Ridge and Argonne National Laboratories, Lawrence Radiation Laboratory, and Battelle Memorial Institute. Dr. Forsen is a member of the National Academy of Engineering and is on several advisory committees to DOE laboratories. He holds a PhD in electrical engineering from the University of California at Berkeley.

Walter Kovalick is the Director of the Technology Innovation Office, Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. Prior to this position he served as Acting Deputy Administrator for the Office of Solid Waste and Emergency Response. For five years, until December 1989, he was the Deputy Director of the Superfund program. He holds an MBA from Harvard Business School and a PhD in public administration and policy from Virginia Polytechnic Institute.

Michael L. Mastracci is the Director of the Innovative Programs for TECHMATICS, Inc. of Fairfax, VA. From 1972–1995, he has held various positions in the Research office of the U.S. Environmental Protection Agency. Before working in government, he held a number of department level positions with the AMF and Wester Gear Corporations. He is an inventor, an international consultant and an active participant in a variety of industry and trade networks, and advisory commissions, all relating to environmental technology development.

Philip Palmer is a senior environmental fellow in the DuPont Chemicals Core Resources Section of the Corporate Remediation Group. He has over 15 years of experience in the field of remediation technology development. He currently heads a group of 40 that is evaluating remediation technologies. Palmer oversees development and pilot testing of new technologies on DuPont sites and assessment of the company's remediation technology needs. Mr. Palmer served as a leader and member of the Chemical Manufacturers Association RCRA Regulations Task Force from the inception of RCRA until 1990. He is a former CGER member. He hold a BS and an MS in chemical engineering from Cornell University. He holds an MS in environmental engineering from Drexel University.

Rebecca Tyrrell Parkin is concurrently the Director of Scientific, Professional and Section Affairs at the American Public Health Association and the President of Beccam Services where she specializes in occupational and environmental health, and policy analysis. Dr. Parkin was previously Assistant Commissioner in the Division of Occupational and Environmental Health, New Jersey Department of Health; Epidemiologist, Centers for Disease Control; and Chief of the Environmental Health Program, New Jersey Department of Health. She holds an MPH in environmental health and a PhD in epidemiology from Yale University.

Alfred Schneider is currently Emeritus Professor of Nuclear Engineering at Georgia Institute of Technology; and President of Schneider Labs Inc.

Prior to these positions Dr. Schneider was Director of Nuclear Technology of Allied General Nuclear Service in South Carolina. He is a member of the American Chemical Society, American Institute of Engineers, American Nuclear Society, and American Association for Advancement of Science. Dr. Schneider holds a PhD from the Polytechnic University of New York.

Christine Shoemaker is Professor and Chair of the Department of Environmental Engineering at Cornell University. Dr. Shoemaker has been a panel member for the NRC committee on pest control and the Environmental Studies Board's Scientific Council on Problems of the Environment. She was also a member of the FAO Expert Panel on Pest Management. Her research involves the application of optimization, statistical, and mathematical analysis to environmental problems. She holds a PhD in mathematics from the University of Southern California.

C. Herb Ward is Foyt Family Chair of Engineering, Professor of Environmental Science and Engineering and Ecology and Evolutionary Biology, and Director of the Energy and Environmental Systems Institute at Rice University. He has served on the National Research Council's Committee on Multimedia Approaches to Pollution Control, Advisory Committee on Multiagency Hazardous Wastes Research, and Committee on Alternatives for Ground Water Cleanup. Dr. Ward holds a PhD from Cornell University and an MPH from the University of Texas.

John T. Whetten is a Senior Applications Consultant to Motorola in Los Alamos, NM. He was previously Associate Director for Energy and Technology at Los Alamos National Laboratory. Dr. Whetten has many years of experience in research for the U.S. Geological Survey in Seattle; and in university teaching, research and administration at the University of Washington. He holds a PhD in geology from Princeton University.

Raymond G. Wymer is currently an independent consultant based in Oak Ridge, TN. Dr. Wymer is retired Director of the Chemical Technology Division at Oak Ridge National Laboratory where he worked for over 20 years. He also served as an Associate Professor at the Georgia Institute of Technology and as Chief Nuclear Chemist for Industrial Reactor Labs. Dr. Wymer holds a PhD from Vanderbilt University.

BIOGRAPHICAL INFORMATION FOR MEMBERS OF THE SUBCOMMITTEE ON THE INTEGRATION OF SCIENCE, ENGINEERING, AND HEALTH IN PROGRAM IMPLEMENTATION

Victoria J. Tschinkel is Senior Consultant for environmental issues at the law firm of Landers and Parsons in Tallahassee, Florida. From 1981 to 1987, she was Secretary of the Florida Department of Environmental Regulation, serving as the agency's chief administrative and policy officer. Ms. Tschinkel is Chairman of the Advisory Council of the Gas Research Institute and a Fellow of the National Academy of Public Administration. She received her B.S in zoology from the University of California at Berkeley.

Betsy Ancker-Johnson has been Chairman (pro bono) of the World Environment Center since 1988. She is retired Vice President of General Motors Corporation, Environmental Activities Staff, 1979–1992. She was Assistant Secretary of Science and Technology in the US Department of Commerce from 1973–77; and Associate Laboratory Director for Physical Research at National Laboratory in Argonne, IL, from 1977–79. She holds a PhD in physics from Tubingen University and several honorary degrees.

Philip Brodsky is Director of Corporate Research and Environmental Technology at Monsanto Company in St. Louis, Missouri. He first joined Monsanto as a senior research engineer in 1969 and has filled successive positions as research specialist, group leader, senior group leader, manager, and director of research and development before taking his current position in 1987. Dr. Brodsky holds a PhD in chemical engineering from Cornell University.

David S.C. Chu is currently Director of RAND's Washington Research Department. He is former Assistant Secretary of Defense for Program Analysis and Evaluation, US Department of Defense; Assistant Director, National Security and International Affairs Division, Congressional Budget Office; and Senior Economist and then Associate Head, Economics Department, Rand Corporation. Dr. Chu received his BA, MA, M. Phil., and PhD, all in economics, from Yale University.

Benjamin A. Cosgrove is retired Senior Vice President for Technical and Government Affairs for the Boeing Commercial Airplane Group and is a 44-year veteran employee. He was BCAG's senior executive on safety matters. In 1992 he became Senior VP for Technical and Government Affairs. Mr. Cosgrove is a member of the National Academy of Engineering Mr. Cosgrove holds a BS from Notre Dame and an Honor Award from Notre Dame's College of Engineering.

Brian Costner has been Director of the Energy Research Foundation (ERF) in Columbia, SC, since June 1989. Mr. Costner was a member of the working group which established the charter for the SRS Citizens Advisory Board and is now a member of that Board and chair of the Board's subcommittee on Risk Management and future use. In September 1994, Mr. Costner was appointed to DOE's Environmental Management Advisory Board, where he serves on the Executive Committee, Risk Committee, Budget Committee, and as chair of the NEPA Compliance Practices Committee.

Robert C. Forney is retired Executive Vice President of E.I. du Pont de Nemours and Co. He joined Du Pont as Research Engineer in 1950 and advanced in various research, technical and marketing management positions. Mr. Forney is a member of the National Academy of Engineering, the Society of Chemical Industry, the American Chemical Society, the American Institute of Chemical Engineers, the American Association for the Advancement of Science and Sigma Xi. He holds an MS in industrial engineering and a PhD in chemical engineering from Purdue University.

James Johnson Jr., is Professor and Acting Dean of the School of Engineering at Howard University in Washington, DC. He is also a member of the Environmental Engineering Committee of US EPA's Science Advisory Board and of the National Research Council's Committee on the Remediation of Buried and Tank Wastes. Dr. Johnson is Associate Editor of the *Journal of Hazardous Materials*. He holds an MS from the University of Illinois and a PhD from the University of Delaware.

Mildred McClain is Executive Director of Citizens for Environmental Justice in Savannah, GA. She is also a Senior Consultant for Educational Enterprises providing advice to schools, organizations, businesses and national campaigns in the areas of organizational development, community development, grassroots organizing, crisis intervention, program planning, and many other areas. She is a former high school teacher and has directed community organizations on a variety of social issues. Dr. McClain received her doctorate of education from the Harvard Graduate School of Education.

Bernice K. McIntyre is President of B.K.McIntyre & Associates, Inc. She was previously Manager in the Utility Management Practice of Arthur D. Little, Inc.; and served as Chairman of the Massachusetts Department of Public Utilities prior to joining Arthur D. Little. Ms. McIntyre has extensive experience in telecommunications, utility and environmental regulation. She was a member of President Clinton and Vice President Gore's Transition Team to develop policy and personnel recommendations. She holds a JD from Boston University School of Law.

Maxine L. Savitz is currently General Manager of Ceramic Components at Allied Signal Aerospace Company. From 1979–83 she was Deputy Assistant Secretary for Conservation at the Department of Energy, followed by President of the Lighting Research Institute at the Department of Energy, 1983–85. Before joining her present company, Ms. Savitz was Assistant Vice President of Engineering at the Garrett Corporation. She is a member of the National Academy of Engineering and holds a PhD in organic chemistry from the Massachusetts Institute of Technology.

Appendix D Biographical Information on Workshop Speakers and Participants

EVALUATION OF REGULATORY MEASURES WORKSHOP

Carol J. Henry is the Science and Policy Director of the Office of Integrated Risk Management at the Department of Energy (DOE). She is responsible for the development of major policies, systems and guidelines for DOE's Environmental Management risk management programs and activities and she reports directly to the Assistant Secretary for Environmental Management. From 1992–94 Dr. Henry was the Director of the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. She was previously the Executive Director of the International Life Sciences Institute's Risk Science Institute in Washington, DC. Dr. Henry holds a PhD in Microbiology from the University of Pittsburgh and has done post doctoral work at the Max Planck Institute in Tubingen, at Princeton University and at the Sloan Kettering Institute.

Ellen Livingston-Behan is Acting Executive Officer, Office of Environmental Management, Department of Energy (DOE).

Andrew Lawrence is Director of the Compliance Assistance Division, DOE. Prior to this he was Special Assistant to the Director of the Office of Environmental Compliance. Mr. Lawrence holds a BA in American Studies from Amherst College and an MS in Science and Technology Policy from American University.

Joseph Fitzgerald Jr. serves as the Deputy Assistant Secretary for Worker Health and Safety in the Department of Energy's Office of Environment, Safety, and Health. Prior to this position, he served as the Director of the Performance Assessment Division of the Department of Energy's Office of Nuclear Safety. In addition, he also served as the Department of Energy's Director of Safety Policy within the Office of the Assistant Secretary for Nuclear Safety. Mr. Fitzgerald holds a BS in Environmental Engineering and an MS in Public Health and Environmental Engineering from Tufts University and an MPH in Radiological Health Protection from the University of Minnesota.

Elizabeth Cotsworth is currently the Deputy Director of the EPA Office of Solid Waste. She has held a series of positions within the Office of Solid Waste since joining OSW in 1978. Most recently, Ms. Cotsworth was the Deputy Director, OSW Waste Management Division, where she was involved in implementing the RCRA land disposal restrictions program, performing national waste management capacity analysis, and developing hazardous waste combustion regulations. She holds a BA from Chatham College and an MA from the University of Virginia.

Camilla Warren is Chief of the DOE Remedial Section, Federal Facilities Branch, U.S. EPA Region IV. Prior to this she worked with the RCRA Compliance Unit also in Region IV. Ms. Warren has twelve years combined experience working on issues involving Superfund and RCRA. Her experience includes settlement negotiations involving Superfund sites and federal facility agreements with DOE. Ms. Warren holds a BS in Forest Hydrology from the University of Georgia and MS in Environmental Engineering from Clemson University.

John Austin is Chief of the Performance Assessment and Hydrology Branch of the Division of Waste Management of the Office of Nuclear Material Safety and Safeguards. In this position he is responsible for the development and application of performance assessment methodologies for low-level and high-level waste disposal sites as well as for materials sites undergoing decommissioning through burial of contaminated soils and slags on site. Dr. Austin holds a BS in Chemical Engineering from Purdue University, a Master's degree in Engineering Science from the University of California at Berkeley, and a PhD in Nuclear Engineering from North Carolina State University.

Samuel Goodhope is the Special Assistant Attorney General in the Office of the Attorney General, State of Texas. He is responsible for advising Attorney General Dan Morales on issues regarding federal facility (DOE and DOD) and federal program environmental cleanup, compliance, pollution prevention, and other policy issues. Mr. Goodhope served on Governor Ann Richards' Task Force on Economic Transition and has been involved with remediation issues at closing or realigned bases in Texas such as Bergstrom Air Force Base, Chase Naval Air Station, Dallas Naval Air Station, and Caswell Air Force Base. He holds an AB in Economics from the University of California at Berkeley and a JD from the Harvard Law School.

Joseph Nagel currently owns a small environmental consulting firm, Nagel Environmental Consulting. Prior to this he was Director of the Department of Environmental Quality for the State of Idaho. Mr. Nagel has also worked on environmental issues at the local and federal government level. He holds a BA in Philosophy and a Master's degree in History from Denver-St. Thomas, Denver, CO.

Donald Macdonald has served as the Executive Assistant to the Manager of the Idaho Operations Office since February of 1994. In this position he reports to and assists the Manager of the Idaho Operations Office in directing and overseeing the activities of the Idaho National Engineering Laboratory (INEL). Prior to this he was manager of the Buried Waste Program for the

DOE-ID where he was responsible for the management of a range of activities dedicated to remediating the environmental risks posed from the burial of radioactive and hazardous wastes at the INEL. Mr. Macdonald holds a Bachelor's degree in History and Political Science from Colorado College in Colorado Springs.

Louis Bogar is a consultant specializing in radiological site remediation and nuclear safety assessments. He is currently involved with the Waste Isolation Pilot Plant in assessing the operational readiness status. Mr. Bogar has a broad background in the management of nuclear safety and technology. He worked for the Westinghouse Electric Corporation for 28 years serving as Vice President at Westinghouse Materials Company of Ohio from 1986–1992. He retired from Westinghouse in September 1992. Mr. Bogar holds an SB in chemistry from the Massachusetts Institute of Technology where he also studied Nuclear Engineering at the graduate level.

Adam Babich is editor-in-chief of ELR-The Environmental Law Reporter and directs the publications division of the Environmental Law Institute, a nonprofit, nonpartisan organization dedicated to improving environmental law through research, dialogue, and education. He is also an adjunct professor at the Georgetown University Law Center. While in private environmental law practice, Mr. Babich's clients included citizen's groups, municipalities, and members of the regulated community. He was the lead plaintiff's counsel on two citizen's suits about the Rocky Flats nuclear weapons plant. Mr. Babich holds a JD from the Yale Law School.

Elmer Akin is Chief of the Office of Health Assessment, Waste Management Division, Region IV, U.S. EPA. Prior to this he was Director of the Toxicology and Microbiology Division, Health Effects Research Laboratory, U.S. EPA, Cincinnati, OH.

Lokesh Chaturvedi is the Deputy Director of the Environmental Evaluation Group (EEG) of the New Mexico Institute of Mining and Technology, in Albuquerque, New Mexico. The EEG performs independent scientific evaluation of the Waste Isolation Pilot Plant (WIPP) on behalf of the State of New Mexico.

Tom Isaacs is the Executive Director of the Advisory Committee on External Regulation of Department of Energy Nuclear Safety.

David O'Very is the Attorney Advisor/Special Assistant to the Director, Office of Radiation and Indoor Air. Prior to this position he was a legal fellow with the Natural Resources Defense Council. He was the chief editor and contributing author for the book *Controlling the Atom in the Twenty-first Century* published in 1994.

Suzanne Rudzinski is the Director of the Office of Policy Analysis at the DOE Department of Environmental Management.

Milton Russell is the Director of the Joint Institute for Energy and Environment and Professor of Economics at the University of Tennessee. He was previously Assistant Administrator for Policy, Planning, and Evaluation at the U.S. EPA.

PRIORITY SETTING, TIMING AND STAGING OF ENVIRONMENTAL MANAGEMENT ACTIVITIES WORKSHOP

Carol J. Henry is currently the Science and Policy Director of the Office of Integrated Risk Management at the Department of Energy (DOE). She is responsible for the development of major policies, systems and guidelines for DOE's Environmental Management risk management programs and activities and she reports directly to the Assistant Secretary for Environmental Management. From 1992–94 Dr. Henry was the Director of the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. She was previously the Executive Director of the International Life Sciences Institute's Risk Science Institute in Washington, DC. Dr. Henry holds a PhD in Microbiology from the University of Pittsburgh and has done post doctoral work at the Max Planck Institute in Tubingen, at Princeton University and at the Sloan Kettering Institute.

Douglas L. Weaver is Independent Review Program Manager at Sandia National Laboratories. He has 24 years experience in the management and operation of complex manufacturing facilities and is currently applying this experience to support a DOE Environmental Management Program need for independent reviews (Red Teams) of programs and projects. Mr. Weaver has led Red Team reviews and evaluations at the Rocky Flats Plant, Oak Ridge National Laboratory Isotopes Facilities, Mound Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories and Brookhaven National Laboratory. He has participated in reviews of other plants including Hanford, Savannah River, and Pinellas. Mr. Weaver also provides planning and management consulting support to several elements within the Department of Energy. [He was a speaker at the previous workshop on Priority-Setting, Timing and Staging.]

Bob Anderson is Project Leader of the Prioritization, Environmental Health and Safety Division at Los Alamos National Laboratory.

Curtis C. Travis is Director of the Center for Risk Management at Oak Ridge National Laboratory. He is a Fellow of the International Society for Risk Analysis and a Senior Research Fellow with the Energy, Environment, and Resources Center at the University of Tennessee. His research interests include exposure assessment, pharmacokinetics, environmental policy, science-based risk analysis and effectiveness of environmental technologies. Dr. Travis serves on numerous advisory boards and holds a PhD in applied mathematics from the University of California at Davis.

John S. Applegate is the James B. Helmer Jr., Professor of Law at the

University of Cincinnati College of Law, where he teaches environmental law, administrative law, and torts. He chairs the Fernald Citizens Task Force, a site-specific advisory board established by the US Department of Energy to advise it on the central environmental issues arising out of the clean-up of the formal nuclear weapons facility in Fernald, Ohio. He is also a member of the DOE's Environmental Management Advisory Board. Professor Applegate previously practiced law with the firm of Covington & Burling in Washington, DC. He received his JD from Harvard Law School.

Susan Wiltshire is Vice President of JK Research Associates, a consulting firm specializing in public policy formulation, strategic planning and citizen involvement for technical programs. Ms. Wiltshire is Chairman of the US EPA Advisory Committee on the Waste Isolation Pilot Plant and a member of EPA's Advisory Committee on Radiation Site Cleanup Regulation. Her current appointments include membership on the Committee on Technical Bases for Yucca Mountain Standards and the Committee to Review New York State's Siting and Methodology Selection for Low-Level Radioactive Waste Disposal, which she chairs.

Toby Michelena is Coordinator of Tank Waste Remediation Systems at the Washington State Department of Ecology.

Lee W. Merkhofer is currently a Principal at Applied Decision Analysis, Inc. and has more than 20 years of experience in the research, teaching, and application of formal decision and risk analysis. Best known for his analyses of public health and environmental issues, he also serves commercial clients in risk analysis and planning. Dr. Merkhofer's research includes analyses of national air quality standards, energy and waste facility siting decisions, and space mission planning. Before joining ADA he was Associate Director and Manager of Research Programs, Decision Analysis Group, SRI International. He holds a PhD in engineering-economic systems from Stanford University.

Brian Costner is Director of the Energy Research Foundation. He regularly works to interpret the Savannah River Site environmental , safety, health, and production activities within the context of overall Department of Energy programs and policies. Mr. Costner was a member of the working group which established the charter for the Savannah River Site Citizens Advisory Board and is now a member of that Board. He also helps design and implement many activities with the Military Production Network, and is a member of the Medical University of South Carolina's Environmental Risk Management Advisory Committee. He is also a member of the South Carolina

Research Authority's Reclamation and Reduction of Nuclear Residuals Advisory Board.

Julie D'Ambrosia is a Program Director of EnviroTech Associates, a consulting firm providing technical support to the Department of Energy's Office of Environmental Restoration, where she facilitates technical and programmatic information exchange between the Office of Environmental Restoration, external organizations, and the public. She has nearly 20 years of technical experience in DOE's waste management and environmental restoration programs. From 1991–94, Ms. D'Ambrosia served as a technical assistant to the Deputy Assistant Secretary for Environmental Restoration. Prior to that, she was responsible for management of high level waste and transuranic waste at DOE's Savannah River Site, worked at DOE headquarters as the Waste Operations program manager for the Hanford, Idaho, Albuquerque, and Nevada sites, and performed research on plutonium chemistry at the Hanford site.

Robert N. Ferguson is Oversight Administrator at the Idaho National Engineering Laboratory and is directly responsible to the Governor of the State of Idaho. He is a senior-level nuclear professional with over 30 years of diverse, in-depth experience in the nuclear industry. His expertise includes reactor operations, design engineering, project engineering, project management, and corporate management. His extensive experience demonstrates strong capabilities in project management and assessments. Mr. Ferguson was previously Senior Engineer at Science Applications International Corporation; Vice President of LRS Consultants Incorporated; and Vice President of Engineering & Systems at Energy Incorporated. He holds a BS in mechanical engineering from the University of Wyoming and an MBA from the University of Idaho.

Mark Gilbertson is Program Director of the Office of Integrated Risk Management at the US Department of Energy.

WORKSHOP ON UTILIZATION OF SCIENCE, ENGINEERING, AND TECHNOLOGY

Carol J. Henry is the Science and Policy Director of the Office of Integrated Risk Management at the Department of Energy (DOE). She is responsible for the development of major policies, systems and guidelines for DOE's Environmental Management risk management programs and activities and she reports directly to the Assistant Secretary for Environmental Management. From 1992–94 Dr. Henry was the Director of the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. She was previously the Executive Director of the International Life Sciences Institute's Risk Science Institute in Washington, DC. Dr. Henry holds a PhD in Microbiology from the University of Pittsburgh and has done post doctoral work at the Max Planck Institute in Tubingen, at Princeton University and at the Sloan Kettering Institute.

John (Mac) Lankford is a staff member at the Department of Energy.

Teresa Fryberger is a staff member at the Department of Energy.

Harry D. Harmon is presently technical director of the High Level Management Division of the Westinghouse Savannah River Company where he oversees all divisional research and development efforts for the company and for the Department of Energy. Dr. Harmon has held research and managerial positions in many divisions of the Savannah River Laboratory since he joined the project in 1973. Prior to the Savannah River Company, Dr. Harmon was assistant professor of Chemistry at Walters State Community College in Morristown, TN. He holds a BS in Chemistry from Carson-Newman College in Jefferson City, TN, and a PhD in Inorganic and Nuclear Chemistry from the University of Tennessee in 1971.

Walter Kovalick is the Director of the Technology Innovation Office, Office of Solid Waste and Emergency Response, United States Environmental Protection Agency. Prior to this position he served as Acting Deputy Administrator for the Office of Solid Waste and Emergency Response. For five years, until December 1989, he was the Deputy Director of the Superfund program. He joined EPA in 1970 from one of its predecessor agencies. Dr. Kovalick is a member of the American Society for Public Administration, the Institute for Industrial Engineers, and the Academy of Management. He holds a MBA from Harvard Business School and a PhD in Public Administration and Policy from Virginia Polytechnic Institute.

John B. Carberry is currently director of Environmental Technology for E.I. DuPont in Wilmington, DE. He has held a series of management and developmental positions within DuPont since joining them in 1965, and Mr. Carberry presently represents DuPont as the U.S. Regional Coordinating Partner in the IMS Initiative for Cleaner Technologies. In addition, he has also served on numerous advisory boards and committees for universities and organizations. Mr. Carberry holds a BS and an MS in Chemical Engineering from Cornell University and an MBA from the University of Delaware in 1974. He is a member of the National Academy of Sciences.

Rebecca Tyrrell Parkin is concurrently the Director of Scientific, Professional and Section Affairs at the American Public Health Association and the President of Beccam Services where she specializes in occupational and environmental health, and policy analysis. She has also been an Adjunct Assistant Professor in the Department of Environmental and Community Medicine, University of Medicine and Dentistry of New Jersey, since 1984. Dr. Parkin was previously Assistant Commissioner in the Division of Occupational and Environmental Health, New Jersey Department of Health; Epidemiologist, Division of Birth Defects and Developmental Disabilities, Center for Environmental Health and Injury Control at the Centers for Disease Control; and Chief of the Environmental Health Program, New Jersey Department of Health. She holds and MPH in Environmental Health and a PhD in Epidemiology from Yale University.

J. Robert (Bob) Hightower is director of the Center for Waste Management and manager of the Integrated Mixed Waste Program of the Energy Systems Waste Management Organization in Oak Ridge, Tennessee. His responsibilities involve management of all mixed waste activities and coordination of all technology development activities for all waste types sponsored by the Office of Waste Management on the Oak Ridge Reservation. Dr. Hightower holds a BS from the University of Mississippi and a PhD from Tulane University, both in Chemical Engineering.

Gretchen H. McCabe is currently senior research scientist with the Battelle Company in Seattle, WA, where she specializes in assessing environmental issues from technical and public policy perspectives. Her recent work includes analyzing public, regulatory, and technology user acceptance of deploying new waste management and environmental remediation technologies. Prior to Battelle, Ms. McCabe spent five years at the Congressional Office of Technology Assessment (OTA) working in the environmental technology and policy arena. Ms. McCabe holds a BA in geology and an MS in political science from the Massachusetts Institute of Technology.

Roger P. (Pat) Whitfield is retired from the Department of Energy as the deputy assistant secretary for environmental restoration. He holds a BS and an ME from the University of Alabama and an MBA from Florida State University.

Christopher J. Nagel is a co-founder and Executive Vice President of Science and Technology of Molten Metal Technology, Inc., a company engaged in the development and commercialization of an innovative chemical processing technology, known as Catalytic Extraction Processing (CEP). From 1986 to 1991, Dr. Nagel was a doctoral student in the School of Chemical Engineering at M.I.T. Dr. Nagel was employed by USX (previously U.S. Steel) where he served as Manager of Energy Conservation and Coordination from 1982 to 1986. Dr. Nagel holds a ScD in Chemical Engineering from M.I.T. and a BS in Chemical Engineering from Michigan Technological University.

David Rubenson is a senior public policy analyst at RAND in Santa Monica, California. At RAND since 1980, Mr. Rubenson has worked on research projects involving energy, environmental, and natural resource policy. Recently he has focused his efforts on the environmental program of the Department of Defense and on U.S. environmental policy including an analysis of 1990 Clean Air Act's requirements for Automobile Inspection and Maintenance (I&M). Mr. Rubenson holds an MS in Physics from the University of Pennsylvania and an MBA from the University of California, Los Angeles.

Edwin H. Clark II is President of Clean Sites, Inc., in Alexandria, VA. He is former Secretary of the Delaware Department of Natural Resources and Environmental Control, Vice President of the Conservation Foundation, and Acting Assistant Administrator of the pesticides and toxic substances program in the Environmental Protection Agency. He holds a PhD in applied economics from Princeton University.

INTEGRATION OF SCIENCE, ENGINEERING AND HEALTH IN PROGRAM IMPLEMENTATION

Daniel A. Abramowicz is Manager of the Environmental Laboratory at General Electric Corporate Research and Development. He is responsible for developing GE's environmental research program, including remediation, pollution prevention waste minimization, and product stewardship efforts. He is concurrently an Adjunct Professor in the Department of Biology at Rensselaer Polytechnic Institute. Dr. Abramowicz joined GE Corporate R&D in 1984 as Staff Chemist; in 1988 he became Manager of the Environmental Technology Program, and in 1992 Manager of Bioremediation Branch, before succeeding to his current position in 1993. He serves on the Advisory Board of the Idaho National Engineering Laboratory and on the Executive Board of the New York State Hazardous Waste Management. Dr. Abramowicz has published extensively and holds an MS and a PhD in physical chemistry from Princeton University.

John S. Applegate is the James B. Helmer Jr., Professor of Law at the University of Cincinnati College of Law, where he teaches environmental law, administrative law, and torts. He chairs the Fernald Citizens Task Force, a site-specific advisory board established by the US Department of Energy to provide advise on the central environmental issues arising from the clean-up of the formal nuclear weapons facility in Fernald, Ohio. He is also a member of the DOE's Environmental Management Advisory Board. Professor Applegate previously practiced law with the firm of Covington & Burling in Washington, DC. He received his JD from Harvard Law School. [He was a speaker at the previous workshop on Priority-Setting, Timing and Staging.]

Deborah R. Bennett is Staff Member of the Environmental Management/ Red Team of the US Department of Energy at Los Alamos National Laboratory (LANL) since 1992. She has seventeen years experience with commercial, defense, and space nuclear power systems, and assessments of Department of Energy facilities and processes. Ms. Bennett has worked at LANL since 1978 when she joined the Gas-Cooled Fast Breeder Reactor Experimental Program. Subsequent positions included work in Carbide Fuel Development; Technical Assistance to Nuclear Regulatory Commission; Technical Assistance to Office of Defense Energy Projects, DOE Office of Nuclear Energy; SP-100 Nuclear Subsystems, Manager and Section Leader; and New Production Reactor Safety Project Office. She holds a BS and is pursuing an MS in mechanical engineering from the University of New Mexico.

Ken Glozer is Senior Advisor to the Assistant Secretary for Environmental Management-Thomas P. Grumbly. Mr. Glozer is responsible for the design and implementation of initiatives to make the cleanup program efficient and effective. His prior position was Deputy Associate Director, Office of Management and Budget in the natural resource environment and energy area. Mr. Glozer has been a senior ranked federal career official for 20 years and has extensive experience with reforming and restructuring across a large number of federal programs and agencies. Prior to his federal career, he was with Peat, Marwick, Mitchell & Company. He holds an MBA from George Washington University.

Rear Admiral Richard J. Guimond is the Principal Deputy Assistant Secretary for Environmental Management at the US Department of Energy. A Commissioned Officer in the US Public Health Service since 1970, he was appointed Assistant Surgeon General to C. Everett Koop in 1989. Prior to assuming his duties at the DOE, Rear Admiral (RADM) Guimond served on extended detail to the Environmental Protection Agency (EPA) for most of his career. He joined EPA at its inception and served in a number of different capacities, the most notable being the Acting Assistant Administrator for Solid Waste and Emergency Response and the Deputy Assistant Administrator for Solid Waste and Emergency Response. RADM Guimond is the recipient of numerous awards and honors, and holds an Master of Engineering from Rensselaer Polytechnic Institute in 1970 and an MS in environmental health from Harvard University in 1973.

Kevin Holtzclaw is Senior Program Manager of General Electric Company's Environmental Remediation Program since July 1991. Prior to this position, he was Manager of GE Corporate Environmental Programs in the Mid-Atlantic and Southeast Regional Office. Mr. Holtzclaw joined GE Nuclear Energy Division in 1969 working in the area of Nuclear Fuel Research and Development. In the succeeding 18 years with GE Nuclear he had a variety of assignments in the areas of design, safety and environmental analyses, licensing and risk assessment. Mr. Holtzclaw was heavily involved in the evaluations of the Three Mile Island and Chernobyl Accidents. In late 1987, he transferred to GE's corporate office to manage hazardous waste remediation programs where he was responsible for a number of Superfund site cleanups. He holds an MS in mechanical engineering from the University of California at Berkeley.

Richard C. Marty is Senior Engineer Specialist in Risk Assessment and Waste Management at Jason Associates Corporation. His current work involves supporting Rocky Flats in consolidating Operable Units and developing a site-wide treatment strategy for contaminated groundwater. He has extensive experience in the design of cleanup strategies for sites contaminated with hazardous and radioactive constituents. His Independent Technical Review

Team experience has included reviews of projects at Brookhaven National Laboratory and Los Alamos National Laboratory. Dr. Marty was also the leader of special projects and shoreline assessment teams assessing damage and designing cleanup strategies for Exxon Operations following the *Exxon Valdez* incident. He has supported environmental characterization and cleanup design efforts for a wide variety of DOE and private sector clients. He holds an BS in biology and an MS in geology from Portland State University and a PhD in geology and geochemistry from Rice University.

Henry E. (Hank) McGuire is Vice President of Business Development with Scientific Ecology Group, a subsidiary of Westinghouse Corporation. He is responsible for western region business development both inside and outside of the Department of Energy complex. Mr. McGuire has over 25 years experience in the treatment storage and disposal of municipal, hazardous and radioactive mixed waste, most recently as Vice President for Waste Management activities for the Westinghouse Hanford Company. He holds a BS in civil engineering from Worcester Polytechnic Institute and an MS in environmental engineering from Loyola Marymount University, with additional graduate work in chemical engineering and industrial waste treatment at Vanderbilt University.

Philip A. Palmer is Senior Environmental Fellow at I.E. du Pont de Nemours & Company in the DuPont Chemicals Core Resources Section of the Corporate Remediation Group. He has over 15 years of experience in the field of hazardous waste management, the last 5 of which has been devoted to remediation technology development. He currently heads a group of 40 people that is evaluating remediation technologies and he oversees development and pilot testing of new technologies on DuPont sites and assessment of the company's remediation technology needs. He served as a chairman and member of the Chemical Manufacturers Association RCRA Regulations Task Force from the inception of RCRA until 1990. Mr. Palmer holds an MS in chemical engineering from Cornell University and an MS in environmental engineering from Drexel University. [He is a member of the Subcommittee on Utilization of Science, Engineering and Technology.]

Gail M. Pesyna is the Deputy Assistant Secretary for Management and Finance in the Office of Environmental Management. She is responsible for financial management, information systems, procurement, and personnel and administrative management activities for the Environmental Management program. Previously, Dr. Pesyna was Business Operations Manager for DuPont Printing and Publishing. She has a background in operations management, sales management, marketing, and new business development in DuPont's "high-tech" businesses, including Pharmaceuticals and Medical Diagnostics.

Prior to 1981, Dr. Pesyna worked as a science and technology policy analyst for the US Congress and a budget examiner for the US Office of Management and Budget. She holds a PhD in analytical chemistry and computer science from Cornell University, and is a member of Sigma Xi and Phi Beta Kappa.

Patricia A. Rivers is the Assistant Deputy Under Secretary of Defense for Environmental Cleanup in the Office of the Secretary of Defense, US Department of Defense. She is responsible for developing environmental cleanup policy for Defense activities worldwide and for overseeing implementation of that policy by the Military Departments. Prior to this position, she was Chief of the Environmental Division in the Office of the Inspector General, US Department of Defense, from 1990 to January 1994. Ms. Rivers served for thirteen years, beginning in 1977, with the Department of Navy in positions as facilities engineer, environmental engineer, and program manager for the Navy's environmental cleanup program. Ms. Rivers's last assignment in the Department of Navy was in the office of the Chief of Naval Operations, Installation Restoration Branch, where she developed policy for the environmental cleanup program. She holds a BS in civil engineering and is a registered professional engineer in the Commonwealth of Virginia.

Philip Thullen is Program Manager for Independent Technical Reviews (ITR) at Los Alamos National Laboratory, Environmental Management Programs. Dr. Thullen established Independent Review or ''Red Teams'' as a Los Alamos program in June, 1991, and since then, he has led or participated in over 20 ITRs and numerous related spin-off activities. Reviews are typically focused on environmental restoration, waste management, and facility transition. Before joining Los Alamos in 1976, Dr. Thullen was Assistant and Associate Professor of Mechanical Engineering in the Thermal and Fluid Sciences Division of the Mechanical Engineering Department at MIT. Dr. Thullen holds an SM in mechanical engineering and a ScD from MIT. [He was a participant in the previous workshop on Priority Setting, Timing and Staging.]

Douglas L. Weaver is Independent Review Program Manager at Sandia National Laboratories. He has 24 years experience in the management and operation of complex manufacturing facilities and is currently applying this experience to support a DOE Environmental Management Program need for independent reviews (Red Teams) of programs and projects. Mr. Weaver has led Red Team reviews and evaluations at the Rocky Flats Plant, Oak Ridge National Laboratory Isotopes Facilities, Mound Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Sandia National Laboratories and Brookhaven National Laboratory. He has participated in reviews of other plants including Hanford, Savannah River, and Pinellas. Mr. Weaver also provides planning and management consulting support to several elements within the Department of Energy. [He was a speaker at the previous workshop on Priority-Setting, Timing and Staging.]

ENVIRONMENTAL MANAGEMENT TECHNOLOGY–DEVELOPMENT PROGRAM AT THE DEPARTMENT OF ENERGY

1995 REVIEW

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Board on Radioactive Waste Management

Commission on Geosciences, Environment, and Resources

National Research Council

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Cover: View of radioactive waste inside an underground storage tank at the Hanford Site, near Richland, Washington. Photo courtesy of Westinghouse Hanford Co. Special thanks to Jan Hansen.

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PREFACE

The U.S. Department of Energy (DOE) established its Office of Environmental Management (EM) in November 1989. The primary goal of the EM program is to clean up the legacy of environmental pollution at DOE weapons complex facilities throughout the nation. This undertaking costs billions of dollars each year, and its magnitude and complexity demand that related technology development and use be optimized and cost effective, while also reducing risks to public health and meeting program goals and schedules.

At the request of DOE's Assistant Secretary for Environmental Management, Thomas Grumbly, the National Research Council (NRC) formed the Committee on Environmental Management Technologies (CEMT) to provide DOE–EM with continuing independent review and recommendations on technology development and use. (CEMT's formal Statement of Task is presented in Appendix B.) The CEMT membership (see biographical sketches in Appendix C) was constituted to represent the broad span of disciplines required to address its charge. This report is intended to be helpful to those responsible for managing DOE's large and important technology–development programs. The committee will produce a yearly report; the first, published in 1995, describes CEMT's 1994 activities.

CEMT convened its first meeting in December 1994, in Washington, D.C. Open sessions included presentations by NRC Chairman Bruce Alberts, Assistant Secretary for DOE–EM Thomas Grumbly, and DOE Deputy Assistant Secretaries for Environmental Restoration, Waste Management, Technology Development, and Facility Transition and Management. Three invited talks by non–U.S. scientists provided some international perspectives on tank wastes, ground–water cleanup, and mixed wastes. In addition, representatives of DOE–EM's five focus areas gave detailed accounts of their ongoing and proposed work. These five focus areas form the core organization of the DOE–EM tasks: (1) Contaminant Plume Containment and Remediation; (2) Landfill Stabilization; (3) High–Level Radioactive Waste Tank

Remediation; (4) Mixed–Waste Characterization, Treatment and Disposal; and (5) Facility Transitioning, Decommissioning and Final Disposition.

During 1995, CEMT met three times: March 22–23 at the National Research Council, Washington, D.C.; July 31 – August 1 at the J. Erik Jonsson Woods Hole Center in Woods Hole, Mass.; and December 6–8 at the Arnold and Mabel Beckman Center in Irvine, Calif. During the first meeting, presentations were made by senior officials from the DOE, the U.S. Department of Defense, and the U.S. Environmental Protection Agency. At the second meeting, presentations were made by DOE officials and members of organizations carrying out waste remediation functions at the Savannah River Site. At its third meeting, CEMT reviewed the reports of its five subcommittees, received a report from a DOE representative on what actions had been taken in response to the recommendations of CEMT's report for 1994 activities, and prepared this report for 1995 activities.

CEMT wishes to thank members of the DOE–EM staff for their cooperation in presenting material to the committee and its subcommittees, and members of the NRC staff, especially K. T. Thomas, Thomas Kiess, Susan B. Mockler, Patricia A. Jones, and Robin L. Allen, for their support.

Edwin E. Kintner
Chair, CEMT

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EXECUTIVE SUMMARY

The U.S. Department of Energy (DOE) established its office of Environmental Management (EM) in 1989 to oversee the cleanup of hazardous materials at DOE facilities throughout the United States. Due to the public health risks associated with some of those hazardous materials and the high costs of remediation, technologies developed and used for environmental management must be cost effective and achievable with acceptable risks. To help ensure that these critical objectives are achieved, DOE's Assistant Secretary for Environmental Management, Thomas Grumbly, asked the National Research Council (NRC) to review and evaluate the DOE's Environmental Management (DOE–EM) technology–development program. In response to this request, the NRC's Committee on Environmental Management Technologies (CEMT) was established in 1994 to provide DOE–EM with continuing independent review and recommendations on technology development and use.

In addition to the main committee, CEMT formed five subcommittees to address the unique issues relevant to developing technologies for environmental remediation. These five areas, which parallel DOE's focus areas, are defined in the Introduction of this report.

Based on DOE presentations, discussions with DOE staff, and review of DOE documents concerning technology development within EM, the committee has concluded that the DOE–EM's overall program approach based on the focus areas and cross–cutting technologies is a promising one. During the past year, however, DOE–EM has made only limited progress in implementing the recommendations of the committee's first–year report (NRC, 1995). A great deal more needs to be done before the DOE–EM has a vital, focused, and coordinated technology–development program sufficient to support the technically and organizationally complex waste–remediation program effectively. In this report, a number of steps that should be taken to strengthen the DOE–EM program are discussed.

Conclusions and recommendations for each of DOE's five focus areas, as well as some cross–cutting areas, are presented in Chapter 3, whereas, the working papers in Appendix A include more detailed discussions. Based on these specific conclusions and recommendations, five significant points are highlighted that should be helpful to DOE, particularly, in its efforts to further technology–development activities in environmental management. Specific actions that DOE needs to take are to

- **develop and implement quantitative criteria by which technology–development efforts can be prioritized and success can be measured;**
- **carefully consider the waste streams (including those from remediation efforts to their eventual disposition) in determining adequate technology–development needs;**
- **systematically assess and document previous and current efforts to develop and apply technologies using the quantitative criteria mentioned above;**
- **apply effective, external peer review in the selection, evaluation, and prioritization of its projects; and**
- **improve its system for information gathering and documentation on technologies that are available and under development by other relevant organizations in the United States and abroad.**

These points and other recommendations are more fully discussed in Chapter 2.

The EM technology–development program has a major role in determining whether the entire DOE waste–remediation program is carried out well with regard to needs, risk reduction, cost, schedule, effectiveness, and satisfaction. As an indication of its importance, the program, now five years old, has enjoyed stable funding levels, while the budgets of other DOE programs have been reduced. The committee notes a number of items indicative of improvements in the technology–development activities of EM, and recognizes the major effort involved in implementing a program of this scope and magnitude. After observations during 1995, however, CEMT believes that major improvements are needed in the fundamental management processes if the EM research and technology–development program is to meet its responsibilities to the DOE and the public. The recommendations of this report are offered as constructive suggestions to a program that has many competing internal agendas and outside influences.

1

INTRODUCTION

At the request of the U.S. Department of Energy's Assistant Secretary for Environmental Management (DOE–EM), the National Research Council (NRC) formed the Committee on Environmental Management Technologies (CEMT) in 1994 to provide independent review and recommendations to DOE–EM on scientific and technical issues for the environmental management of DOE's weapons complex facilities.

In keeping with the statement of task, CEMT has the following responsibilities:

- review and evaluate DOE–EM's technology–development programs, including guidelines, methodologies, protocols, demonstrations, and applications, with attention to the most important problems facing DOE–EM;
- identify, review, and recommend, as appropriate, new technical criteria and emerging technologies in environmental management that are most relevant to DOE–EM;
- review technology transfer and commercialization issues for DOE–EM technology programs; and
- issue reports, recommendations, and options for DOE–EM's technology development, including substantive annual reports on its activities undertaken during the year and other topical reports when appropriate.

To address the breadth of activities in the EM program, CEMT formed five subcommittees that parallel DOE's five focus areas. The focus areas, which form the basis of DOE's new integrated team structure established in 1994, are: (1) Contaminant Plume Containment and Remediation ("Plumes"); (2) Landfill Stabilization ("Landfills"); (3) High–Level Waste in Tanks ("Tanks"); (4) Mixed–

Waste Characterization, Treatment, and Disposal ("Mixed Wastes"); and (5) Facility Transitioning, Decommissioning and Final Disposition ("D&D"). In addition to the five focus areas, CEMT has also reviewed, in a limited fashion, pertinent cross–cutting areas, including characterization, monitoring and sensor technology; efficient separations and processing; robotics; and disposal.

The role of CEMT is largely programmatic and deals with the overarching issues of technology development, implementation and evaluation, with a focus on the management and soundness of DOE–EM initiatives. An additional role of CEMT is to evaluate specific technologies of importance. Although the subcommittees provide technical information to CEMT, they are not acting as technical project review agents in the focus areas.

During their various meetings, CEMT and its subcommittees were exposed to a cross section of issues related to technology development and were briefed by representatives from DOE headquarters, academia, private industry, national laboratories, and public policy and public interest groups. The topics discussed at these meetings included a variety of technical approaches for management of DOE–EM's complex cleanup, as well as the details of specific technologies.

The different stages of development of DOE's focus areas are reflected in the subcommittee reports (Appendix A), which have been reviewed and accepted by the full CEMT. Because these reports were compiled by five distinct groups, they are presented in various formats. The subcommittee reports should be regarded as works in progress—the preliminary findings are limited by the short time that the subcommittees have been in operation. The five subcommittees have additional meetings scheduled for 1996—generally, at major DOE sites having both R&D and remediation operations. The additional information to be collected at these meetings may augment or modify some of the specific findings presented in the subcommittee reports.

In the next few years, CEMT will continue its study as outlined in its statement of task. The committee will look at issues affecting technology development, including the status of technologies available, strategic goals, performance measures, prioritization schemes, barriers to achieving goals, criteria for technology development, and changes in various regulations and policies.

The limited time available to the committee makes it impractical for the CEMT to be fully aware of all aspects of DOE technology–development activities throughout the weapons complex. Nevertheless, the committee believes that some general principles are now obvious. These conclusions and recommendations are given in Chapter 2.

During the process of evaluating DOE–EM's technology–development program, CEMT has noted several activities that indicate that DOE–EM has made some progress in improving the program. These activities, noted below, should continue.

1. Useful steps seem to be in process to make cooperation among DOE–EM's Waste Management program (EM–30), Environmental Restoration program

(EM–40), and Technology–development program (EM–50) successful in improving technology development throughout EM.

2. Successful LASAGNA™[1] technology demonstrations involving industry, DOE organizations, and EPA offer the promise that it will be a useful technology for remediation of solvents in the subsurface at some sites within the weapons complex.

3. Progress has been made in determining the value of plasma arc and plasma hearth vitrification of mixed wastes and in comparative studies of thermal and nonthermal technologies.

4. The efficient separations and processing cross–cutting area has leveraged the expertise of industry in developing innovative processes for the separation of ^{137}Cs from radioactive wastes.

5. The Digface[2] characterization system is a useful development that uses available site information while retaining the flexibility to acquire information as excavation proceeds. (see Appendix A, Landfills).

The CEMT recognizes the difficulties facing DOE in implementing technology–development programs of this scope and magnitude. The committee is hopeful that this 1995 report will be helpful to those responsible for managing the EM Research and Development (R&D) program and looks forward to providing further support and guidance in subsequent years. The 1995 report has focused more in management and related areas; the 1996 report is expected to be more technology oriented.

---

[1] The LASAGNA™ technology, a trademark of the Monsanto Company, is a system or combination of components in a configuration of electrodes and degradation zones that permits in–situ treatment of contaminants in low–permeability environments. Monsanto Company has coined the word LASAGNA to identify its products and services based on this integrated in–situ remediation technology.

[2] The Digface characterization project being developed by the Idaho National Engineering Laboratory (INEL), Ecology International, and Rust Geotech Inc., is an integrated demonstration of multiple sensors that can be used as part of a retrieval effort. The Digface characterization technology will allow continuous and continually improving monitoring and characterization of the site being remediated.

2

IMPROVING THE DEVELOPMENT OF ENVIRONMENTAL MANAGEMENT TECHNOLOGIES

In its deliberations during 1995 and its review of the subcommittee reports attached in Appendix A, CEMT identified five significant points that DOE should address if it is to manage the development of environmental management technologies effectively.

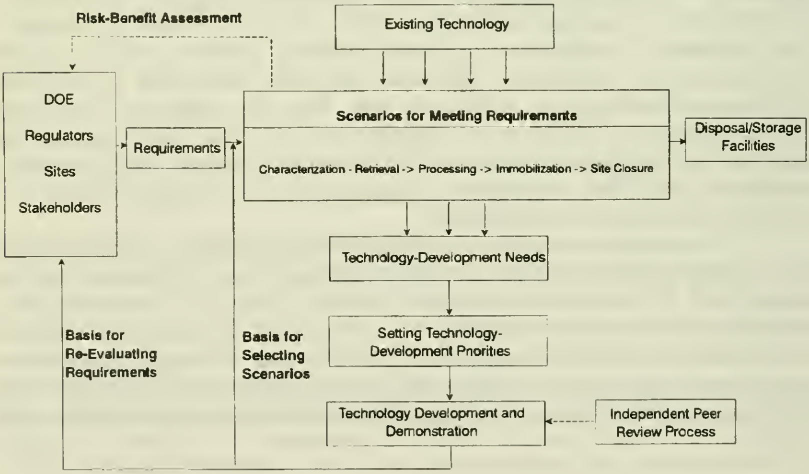
Identification, Selection, and Prioritization of Technology–Development Investments

In an environment of severely constrained federal budgets, setting clear priorities for technology–development investments has become increasingly important. In a previous report by this committee evaluating the development of environmental–management technologies (NRC, 1995), DOE was encouraged to focus technology development on clearly identified problems and to consider systematic use of comparative risk and risk/benefit assessment in evaluating environmental–management alternatives that form the basis for technology–development needs. During the DOE briefings and site visits, CEMT has not seen evidence that this systematic evaluation of alternatives or that any such approach to prioritizing DOE–EM's technology investments based on need, risk, and other important factors has been implemented.

A systematic evaluation of environmental–management technologies must be an underlying framework for prioritizing technology needs. A framework that has worked well for complex technological systems is that of a *structured set of problem/solution scenarios* responding to a *needs assessment*. These scenarios should be evaluated against *explicit quantitative criteria*, based on a robust set of *criteria performance measures* such as risks, costs, schedule, and benefits. Embodied in each scenario are many factors, including different technology requirements, safety impacts, cost implications, and environmental impacts (see Figure 1). The basic approach for prioritizing technology development needs in this manner is outlined below:

- develop and perform an assessment of needs for a given problem or issue;
- develop a comprehensive set of scenarios for different solutions to each problem or issue, covering the major steps from characterization to disposal;
- screen the scenarios to a manageable few, utilizing appropriate screening criteria based on the chosen performance measures;
- quantify the performance measures of an appropriate set of screened scenarios;
- rank the scenarios based on the values assigned to the performance measures; and
- derive the technology–development needs from this ranking of scenarios.

FIGURE 1: RELATIONSHIP OF TECHNOLOGY DEVELOPMENT TO WASTE REMEDIATION


Risk-Benefit Assessment
Existing Technology
DOE
Regulators
Sites
Stakeholders
Requirements
Scenarios for Meeting Requirements
Characterization - Retrieval -> Processing -> Immobilization -> Site Closure
Disposal/Storage Facilities
Technology-Development Needs
Basis for Re-Evaluating Requirements
Basis for Selecting Scenarios
Setting Technology-Development Priorities
Technology Development and Demonstration
Independent Peer Review Process

This process would ensure that the technology needs identified are related to known problems because the scenarios are based on actual problems that must be solved. The process would also assess the relative value of developing technologies that perform as assumed in the scenarios.

Once the technology needs have been identified, evaluated, and prioritized, additional factors on performance measures may be considered in setting priorities among the available technology–development investment options. Additional performance measures could include the likelihood of success and the need for a balanced portfolio of technology–development investments (i.e., a mix of near–term, low–risk investments and longer–term, high–risk, high–payoff investments).

Recommendation: DOE should develop and rank remediation scenarios leading to a prioritized list of technology needs as noted above. The scenarios should be structured to define only the major steps from characterization through disposal (or storage) and to highlight only the major choices to be made. It is important that the scenarios be presented clearly; too much detail can obscure the basic issues.

Careful Consideration of Waste Streams and Their Final Disposal

The need to establish objectives for remediation and disposal also was emphasized in the previous NRC report (NRC, 1995), which stated the following (p. 3):

> While DOE–EM briefers to the committee and submitted documents have identified technologies that will or might be developed, there has been little discussion yet of quantifiable end goals for radioactive contaminants in such terms as final volumes, volume reductions, end product characteristics, and environmental impacts. The levels to which cleanup is required at the sites in which the remediation takes place need reference levels for residual contamination, and specification of future uses for the sites. The criteria for residual impacts on population and the environment do not appear adequately addressed. Development of such criteria has an important bearing on the final cost and feasibility of remedial approaches.

Further, the report stated (p. 4):

> Very little was said [by the presenters] about a crucial component of the overall environmental remediation system, namely, the final destination of removed/immobilized waste material and its separated fractions. Modes of treatment,

> conditioning, and immobilization of wastes are not totally independent from the characteristics of the disposal environment and have to be factored as part of the total system in planning technology development.

Based on DOE presentations, discussions with DOE staff, and review of DOE documents, the committee concludes that these considerations do not appear to have been part of the technology–development program to date. Until such goals are established, it will be impossible to develop an effective focused research and development program with definitive end points.

The committee is aware of the difficulty in the present regulatory and public climate of establishing fixed, precise objectives Nevertheless, the lack of such objectives, even if tentative, is adversely affecting attempts to organize and conduct focused and timely technology development. The end points and technologies must be factored into the system early and with reasonable certainty if the program is to be carried out in a cost–effective and timely manner and with the greatest safety to the public. This process requires, at the very least, that working hypotheses be established by DOE with or without the help of other interested parties as to waste streams and waste–disposal conditions. The eventual environmental impact of waste–management practices results from the combined characteristics of waste–treatment end products, the source term, and the disposal environment. The impact also depends on the behavior of future societies, particularly with respect to various ways in which they inadvertently might intrude into the waste–disposal facility. In fact, most performance assessments show that human intrusion is the dominant pathway of exposure. The types of human intrusion scenarios that are assumed are a matter of policy.

Recommendation: A greater focus should be put on defining the required characteristics of the waste streams and the nature of the ultimate disposal sites, even if tentative and only as working targets, is necessary to manage effectively the EM technology–development program (see Appendix A for more details).

Project Assessment and Evaluation

A previous NRC report (NRC, 1995) states that, "The environmental remediation of the DOE weapons complex is of such a magnitude that in many ways it is an experiment." It is not simply a task of applying known technology with well–understood effectiveness to well–defined cleanup problems In many cases, the DOE complex presents unique waste management and remediation problems for which there is no prior experience, and in others, it faces more common problems (e.g., ground water contaminated with dense nonaqueous phase liquid [DNAPL]) for which there are no current satisfactory remediation options. This view that the DOE environmental remediation program is the largest nondefense technology–

development program in the country, was supported by Assistant Secretary for DOE–EM Thomas Grumbly in CEMT's opening session.

Recognizing the experimental nature of the DOE cleanup problem, the previous NRC report (NRC, 1995, p. 3) pointed out that "...the initial phases of technology development should be considered an exploration of the means to meet environmental remediation requirements. Remediation efforts now underway are also part of the iterative process of technology development and application, which should be recognized by the focus area groups and the steering committee in their integrated team work efforts, and by feedback mechanisms in the system so that future decisions can benefit."

For effective feedback of lessons learned, progress and results must be documented. Performance measures are needed for the technical–development program. In a study of best R&D management practices in private industry[3], more than 50 percent of the respondents put "Learn from post–project audits" in the top third of R&D practices with the greatest potential gain relative to the effort involved.

Systematic evaluation of performance measures is needed in both the technology R&D and technology–application phases, as discussed below.

1. *The R&D phase.* There should be clear criteria for success or failure of technology R&D efforts, and those efforts should be evaluated while they are being conducted so that unpromising research can be terminated. Little evidence has been seen within EM–50 of any systematic approach to such assessment and evaluation. For example, DOE plans four large–scale decontamination and decommissioning (D&D) demonstrations during the next two years, but it is not clear to the committee how these demonstrations will be evaluated and documented to capitalize on their successes and failures for use in future D&D activities.

2. *The application phase.* A technology that appears to work well in the demonstration phase may experience difficulties in large–scale application. For that reason, monitoring of the results of such applications is an important part of an assessment and evaluation program. For example, CEMT's Landfills Subcommittee recommends a focused program of long–term performance assessment of barrier walls and caps, because these are key components of the present DOE environmental–restoration strategy. If privatization is aggressively pursued, it will be essential that documentation of the evaluation and assessment process and the corresponding performance measures be built into the contractual expectations for successful bidders.

It is important to recognize that these evaluations of effectiveness are a necessary part of the learning process and should not be viewed as being intended to fix blame for "failures." The aim is to learn from these demonstrations, whether or not they are judged to be successes. A program of technology development necessarily includes failures as well as successes along the way, and the failures provide valuable information.

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[3] "Lessons Learned from Industrial R&D Management," presentation to the committee by Dr. Michael M. Menke, Strategic Decisions Group, Menlo Park, Calif. on December 6, 1995 at Irvine, California. This study involved a survey of 200 R&D business executives to determine which companies they believed managed R&D best and what areas of improvement they thought most important. This study includes interviews with 22 organizations selected for excellent R&D decision making and identification of 45 "best practices" for R&D decision quality, tests of the findings with over 100 R&D executives in the United States and Europe, and reconfirmation of the findings in a joint survey with the Industrial Research Institute's Quality Director's Network.

Explicit evaluation procedures with quantitative criteria are needed as a basis for determining which projects should be continued and which should be terminated (more detail is provided in the section on prioritization). Termination of R&D projects has been identified by the Industrial Research Institute as one of 12 high–potential activities for improving R&D return.[4]

In this connection, clear identification and evaluation of outcomes would provide a better basis for organizational performance measures than a simple count of completed activities. For example, EM–50 might be scored by considering the number of technological challenges overcome, rather than simply the number of demonstrations conducted, as is now the case in some areas. Similarly, EM–40 might be scored by considering the number of remediation problems positively affected (in risk and/or cost reduction) by implementation of better–than–baseline technology. Use of such performance–based measures would contribute to orienting the DOE organizations toward problem solving.

DOE's ability to apply the results of technology–development efforts will depend to a significant extent on acceptance by outside parties, most importantly, the responsible regulatory authorities and the affected communities and states. For this reason, the committee stated in its previous report (NRC, 1995) that it would be desirable to establish a process "whereby new technology–development efforts and their anticipated results can be taken into account in renegotiating tripartite agreements." The committee believes that the likelihood of acceptance by key outside parties can be enhanced if they are involved in appropriate ways in the process of selecting technologies for development and, of particular importance, the process of assessing and evaluating the results of development and demonstration efforts.

Recommendation: DOE should develop clear protocols and performance measures for assessing and documenting the effectiveness of technology–development projects and field applications. Explicit and measurable criteria for success and procedures for evaluation must be included, including external peer review. Specific evaluation procedures should be included as an integral part of projects, and the results of these evaluations should be documented. These procedures should be applied to current and future projects to identify "lessons learned" that could be applied in future decisions. DOE also should develop a process to disseminate the results of such evaluations throughout the complex to ensure that the lessons are indeed "learned" by decision makers.

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[4] "Improving the Return on Research and Development," Industrial Research Institute, 1984, cited by Michael Menke, Strategic Decisions Group, in a presentation to CEMT, December 6, 1995, Irvine, Calif.

Peer Review

Review of the DOE–EM guidance document on merit review and peer evaluation issued in late 1994 (USDOE, 1994a) provides little evidence that a credible external peer–review system is in place to help guide environmental technology development in the EM program. The external peer–review system needed for this guidance must be separate from, and in addition to, the National Research Council's ongoing role of providing overall programmatic review, because the NRC is not a formal reviewer requiring follow–up by DOE–EM.

Peer review is accepted and widely used as a management mechanism to enhance the quality of R&D programs. To be credible and effective, the peer–review process must assure the technical qualifications of the reviewers and avoid real or perceived conflicts of interest that might affect the outcome. Agencies such as the National Science Foundation (NSF), the Environmental Protection Agency (EPA), the National Institutes of Health (NIH), and the National Aeronautics and Space Administration (NASA) have well–established peer–review procedures (e.g., the Science Advisory Board of the EPA) that have been thoroughly tested and could serve as models for DOE's technology–development program.

High priority should be given to the development and implementation of a rigorous external peer–review process to enhance the scientific and technical quality of the EM technology–development program in the near term. To be most effective, procedures should be standardized as far as possible across all functional elements of EM and especially for all focus areas. The technology review process should be tied to and coordinated with DOE's current system of stages or "gates" that determine the level of maturation for technology development (see Chapter 3, Landfills Focus Area). It is appropriate that internal review should include site representation and technology users to ensure that technology–development efforts are timely and responsive to DOE problem–solving needs. However, external peer review is the appropriate mechanism to ensure the technical soundness and merit of specific projects. Selection of external peer reviewers should be based only on technical qualifications.

Additional mechanisms, such as citizen groups and regulators, should be used to obtain the input of stakeholders. Federal agencies have frequently found it useful to seek the advice of independent scientific and technical groups such as the American Physical Society (APS), the Federation of American Societies for Experimental Biology (FASEB), and the American Institute of Biological Science (AIBS) to identify qualified peer reviewers. Such external technical involvement helps an agency establish and maintain the credibility and competence of its scientific and technological programs.

External peer review can also provide a mechanism for consistent guidance. Each focus area should select qualified experts to serve as peer reviewers on a continuing basis for an extended period. Such an approach would provide long–term guidance by allowing the experts to track decisions made in the DOE remedial technology–development program. Although some focus areas have technical review panels with membership outside of DOE, these panels will not serve the same role as that of external peer reviews.

Peer review can be conducted in many forms: project–focused rapid response, specific technology area review, and comprehensive research needs assessment. By making use of this full range of review modes, DOE–EM can avail itself of constructive criticism without slowing progress toward its technology–development goals.

A helpful associated activity is expert elicitation, which uses expert judgment in a controlled and structured manner to enhance the knowledge base for making a decision. Expert elicitation is being used to provide important input to the performance assessments of the potential repositories and facilities for the disposal and storage of nuclear waste. Agencies such as DOE and the U.S. Nuclear Regulatory Commission (USNRC) are developing detailed guidance documents based on their experiences with expert elicitation. Because of the interrelationship between peer review and expert elicitation, the committee intends to review these guidance documents in future considerations of the peer–review process.

Peer review is being applied to some current programs, such as those of the Landfills Focus Area. Examples of such activities are the review of technology projects presented at the *TRU (transuranic waste), TRU Mixed, and Mixed Low–Level Waste Treatment Technologies Technical Peer Review* (November 13–15, 1995, in Dallas, Tex.), and the *Non–Destructive Assay/Non–Destructive Evaluation (NDA/NDE) Review* (January 25–26, 1996, in Pittsburgh, Pa.) Another documented effort is the recently completed review of a microbial filter project, prior to the commitment of funds for development costs in later stages of development. These examples illustrate that peer review can be used to help guide environmental technology development throughout the EM program.

The committee emphasizes that DOE needs an effective external peer–review process and that it should be implemented in a uniform, consistent manner.

Recommendation: DOE–EM needs to develop and uniformly apply a standardized peer–review process designed to assess the following parameters in all five focus areas: the appropriateness of the identified technology needs, the appropriateness of projects to meet specific technology needs, and the soundness of the technical approach being used or proposed on separate projects.

Information Gathering on Technologies Available and Being Developed in the United States and Abroad

The DOE–EM program needs to improve its awareness and understanding of the availability and development status of technologies applicable to its multiple waste–management problems, not only in its own laboratories and contract organizations, but throughout industry, universities, and worldwide. It should be stated that DOE–EM is not alone in this deficiency; U.S. industry lacks this focus as well. DOE–EM needs this knowledge of available technologies for the three main purposes that follow:

- to compare its technology needs to the status of technology, leading to the identification of technology gaps that require development efforts;
- to ascertain the extent to which proven technologies that exist in other agencies, the private sector, or overseas might be applicable to a specific problem, thus providing the possibility that further technology development is not required; and
- to assess the potential for commercialization and collaborative development of the technologies being considered for development.

Review of the DOE program and documents have shown that DOE's efforts to keep abreast of the status of technologies related to its needs have been inadequate. Technologies that already exist have been redeveloped, more so in areas related to wastes containing hazardous chemicals (e.g., DNAPL issues), than in areas related to wastes containing radionuclides. In addition, developers routinely are urged to pursue commercialization when many technologies are only applicable to unique DOE wastes or situations. There is also a risk that necessary technology development may be affected adversely, using the rationale that privatization could meet the needs, despite the fact that environmental cleanup conditions are unique to the DOE system and there is no incentive for the private sector to develop technologies.

Recommendation: DOE–EM should undertake an explicit effort to inventory the status of technologies relevant to its interests and disseminate the results throughout the program. This inventory should consider both the wastes to be addressed and the conditions (e.g., requirements for remote operation). It should cover both domestic and international venues and all sectors (government, commercial, academic). Such an inventory will allow DOE–EM to identify those research areas where solutions or partial solutions are already available from external sources, as well as those development areas where major DOE–EM technology–development efforts are required.

3

TECHNOLOGY DEVELOPMENT IN DOE: FOCUS AREAS AND CROSS–CUTTING AREAS

Focus Areas

The five CEMT subcommittees reviewed and evaluated the waste–management technology–development activities in the five focus areas of DOE's EM–50 program. Each of the subcommittees has met with DOE headquarters and field staff who have responsibilities for a focus area. In addition, three of the subcommittees have visited the Savannah River Site (SRS) near Aiken, S.C., where waste–management R&D remediation operations are being conducted.

The subcommittees have studied DOE focus–area planning documents and interviewed several levels of management to assess the applicability and quality of the technology–development programs. The subcommittee reports in Appendix A contain the substance of their assessments, including conclusions and recommendations concerning the work of the focus areas. Some of the conclusions and recommendations in the five reports are strikingly similar and apply to the activities of all five of the focus areas and cross–cutting areas.

In the focus and cross–cutting area studies, some general findings of technology development emerged. These same findings are described as the five major points highlighted in Chapter 2. Some of the specific recommendations for the focus and cross–cutting areas are discussed below.

Recommendations: Plumes Focus Area

1. The Plumes Focus Area should identify the major risk and cost drivers associated with remediation of DOE contaminant plumes and develop an integrated systems approach to drive technology development that meets the EM strategic goals of risk reduction, cost efficiency, environmental restoration, and regulatory compliance.

2. The strategic goal recorded in the *Environmental Management Program Strategic Plan* (USDOE, 1994b) highlights the goal of reducing plume characterization expenditures by 50 percent by fiscal year 1997, a goal that seems optimistic. An integrated systems approach is recommended because it might enable DOE to achieve such a cost reduction while still obtaining sufficient characterization data. This recommendation is especially important, because numerous contaminant plumes have not been adequately characterized yet.

3. An assessment should be made of what has been accomplished and learned so far in the Plumes Focus Area. Each remediation or demonstration could be probed to identify successes and lessons learned, addressing the questions of what it did and did not accomplish, and why. These lessons learned could provide valuable scientific data in charting progress and learning about remediation attempts and could serve as a guide for future approaches. It is important to look at all learning experiences as well as successes, because these experiences have valuable information content. Eventually, a good rationale for technology development could be developed, ideally based on both field data and theoretical models.

4. DOE should establish a process for developing specific cleanup goals for each of its contaminated sites within the regulatory framework, because the appropriate approach for remediation of a site depends upon the cleanup goals, intended land use, and technical impracticability issues.

Recommendations: Landfills Focus Area

1. Greater effort is needed in long–term performance testing and monitoring of engineered containment techniques and systems, including covers, caps, barrier walls, and floors.

2. A *problem–solving orientation* in technology development is advocated. The subcommittee acknowledges the focus area's efforts to date in these areas and offers three preliminary suggestions to improve and help implement the problem–solving orientation:

   a) A ranking/categorization for landfill–related problems based on relative risk would be useful to drive technology development in DOE. These analyses need not use sophisticated models and may already exist to some degree in DOE literature.

   b) Technology needs should be established from this risk prioritization and used to identify priority technical tasks.

   c) These technical tasks would then be organized into product lines, based on technology rather than the waste type (e.g., TRU/Mixed Waste–Arid; TRU/Mixed Waste–Non–Arid; Low–Level Waste/Other–Arid; Low–Level Waste/Other–Non–Arid) as is currently the practice. The proposed technology grouping would include five product lines:

      i) characterization (or assessment),

      ii) retrieval (encompassing technology development for any kind of retrieval operations contemplated),

iii) treatment (including both in– and ex–situ methods),
iv) containment and monitoring, and
v) systems integration and design.

3. Each technical project would benefit from clearly established goals, a strategic plan to guide development, and an action plan describing how these strategic goals are to be met. DOE's current system of "gate" reviews is supported and should be used more broadly throughout the Landfills Focus Area as a helpful tool in technology–development planning. Gate reviews are DOE's system of determining the level of maturation for specific technologies. Gates represent the successive stages of technology development in EM–50's "technology maturation model" used to track the project they fund. For instance, the lower–level gates (1–3) correspond to R&D, gate 4 is the stage where the decision whether or not to continue funding the technology is made, and higher–level gates (5 and 6) include demonstration and the final stage of implementation.

Recommendations: High–Level Waste in Tanks Focus Area

1. Substantial technology–development needs remain to be addressed if the high–level waste in tanks is to be successfully remediated. The DOE should continue to support a balanced technology–development program integrated across all involved organizations, including EM–30, –40, and –50, and Energy Research.

2. A number of important technology needs related to managing high–level waste in tanks are common to the four DOE sites that have alkaline nitrate supernatant–saltcake–sludge wastes. For the most part, the needs of the Idaho National Engineering Laboratory (INEL) site are expected to be significantly different from other sites because the waste is acidic. Integrating technology–development efforts would be desirable in order to develop technologies in a cost–effective manner and to share the results to the extent they are applicable at multiple sites. However, the subcommittee has not yet had the opportunity to evaluate the effectiveness of the existing focus area.

3. Program requirements and constraints for technology development should be specifically defined. Issues that should be considered are waste characterization, retrieval from the tanks, processing, immobilization, site closure, and disposal.

Recommendations: Mixed–Wastes Focus Area

1. Because waste treatment is only one, albeit essential, step of the management of radioactive mixed wastes, decisions related to selection of a treatment technology or to development of a new technology should be made in the perspective of optimization of the full waste–management scheme, which includes disposal of the

treated end products. DOE–EM should give full consideration to the characteristics of the final waste form in the perspective of its potential disposal environment. Ultimately, treatment technologies must be evaluated as a total system and in life–cycle context.[5]

2. Selection of treatment technology and decisions to develop new technologies should be based on perceived needs associated with specific waste streams and potential advantages with regard to various issues such as types and quantities of wastes, quality criteria that define the end products and their use, and cost. Application of available and near–mature technologies may still leave some waste–treatment problems unsolved and, for the latter, new approaches may be required. Development of new treatment technologies should focus on adequacy and cost effectiveness of existing technologies for mixed–waste treatment, rather than on new, potentially applicable treatment technologies for mixed–waste streams.

3. Adequate characterization of mixed wastes is a critical element for successful and cost–effective implementation of mixed–waste management. Techniques used for characterization of mixed wastes should be adapted and limited to meet the essential requirements of the treatment processes and waste–management systems.

Recommendations: Decontamination and Decommissioning Focus Area

1. DOE EM–50 has stated to the D&D Subcommittee that new technologies are needed to perform D&D tasks in safer, better, cheaper, and faster ways than are possible with presently available technologies. However, no documentation of the basis for this premise, which is the justification for the entire technology–development program, has been provided to the subcommittee or identified. Further, no basis was found for establishing the level to which sites should be decontaminated other than the need to comply with statutory, regulatory, and contractual requirements. End–use risk and cost are also major drivers. The tri–partite agreements between the state of Washington, EPA, and DOE have been put in place largely without consideration of end use or rigorous risk assessment. As a result, existing statutes and regulations have been applied without adequate analysis of actual risk to populations and the environment.

DOE should establish and document criteria to compare and evaluate the effectiveness of existing and candidate technologies and to identify deficiencies in these technologies. Such criteria should include cost effectiveness, probability of success, time of availability, secondary waste streams, and risk to operators and the public. After this evaluation has been accomplished, the basis for projecting the need for and/or the superiority of future technologies should be stated explicitly. The process should start with a needs assessment for the D&D Focus Area and should identify available technologies, technology gaps, and criteria for establishing priorities. DOE is also in urgent need of defining criteria by which to decontaminate sites on a "necessary and sufficient" basis within regulatory constraints. Such an exercise might indicate that current technologies are adequate to meet many cost and schedule targets. External peer review should be applied to each of these steps as appropriate.

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[5] "Total system" means all steps of waste management from generation to disposal. "Life cycle' refers to all costs and efforts related to the application of a technology, i.e., R&D, delays due to new R&D and demonstration, licensing/acceptance, implementation, etc. Some overlap may exist between the two notions, but they are not identical.

2. The D&D Focus Area 1995 Strategic Plan's emphasis on relatively mature technologies and large–scale demonstrations, is too narrowly focused (USDOE, 1994b). The D&D Focus Area should revise its strategic plan to provide for a comprehensive D&D technology–development program. This plan should specify a process that will yield a systematic assessment of D&D needs and available technologies, identify technology gaps, develop criteria for establishing priorities, and justify each demonstration project that will be funded and executed. This effort should include a balanced program of basic and applied research, exploratory and advanced development, engineering design, demonstration, and implementation. This strategic plan should also be flexible, including provisions for future periodic revisions as new data and experiences are gained.

3. DOE should address planning in terms of a process, as many organizations have found that the most valuable aspect of any strategic–planning exercise is the process of assembling the plan rather than the specific details of the plan. In order for the plans to succeed, DOE decision makers (and not their support contractors) should draft the plans.

DOE managers should set aside time for the planning exercise, which must include the undivided attention of the highest–level decision makers. The plan will succeed best if it has commitment from the highest and broadest levels of management. Different levels of DOE representatives could draft the different plans, but the strategic–planning document must include the highest–level decision makers. Authors of the management plan should include those responsible for managing the plan, and the authors of the implementation plan should include those responsible for implementing the plan. The intent of the above recommendation is to encourage DOE–EM management to identify those activities that are most important and then carry out these high–priority activities effectively.

Cross–Cutting Areas

Appendix A also contains a report on technologies that are generic to and cut across a number of focus–area programs. Three of these technologies are specifically designated by DOE as cross cutting and have their own budgetary designations. These formally recognized cross–cutting technologies are (1) efficient separations and processing; (2) characterization, monitoring, and sensor technologies; and (3) robotics technology. In addition to these three areas, there are other technologies that are broadly applicable but not managed individually. The section, Cross–Cutting Areas and Technologies of Importance in Appendix A, also contains discussions on areas of this type, i.e., vitrification, incineration, supercritical waste oxidation, and disposal technologies. This report covers the topics in varying degrees of detail but generally cites the reasons for the generic interest in each of the cross–cutting technologies. Some preliminary perspective on the status of technology development and on technological challenges requiring further effort is also included. As with the focus–area reviews, additional information will be collected and assessed in 1996. Recommendations to the cross–cutting areas are discussed below.

Recommendations: Cross–Cutting Areas

1. In planning the research and development needed to support a specific remediation project (e.g., the Hanford tanks), the technology–development activities must be structured to produce an integrated system to deal with all aspects of the project: characterization, retrieval, treatment, stabilization, and disposal. For example, the processes developed for separation of the various waste components during the treatment phase must be compatible with one another as well as with the stabilization technology and with the minimization of cost and risk in disposal and storage. Similarly, the stabilization processes must be designed to consider not only the nature of the treated waste but also the disposal conditions and the duration of the storage period.
2. The DOE EM–50 robotics–development program has a broad range of ongoing projects with planned technology demonstrations and assessments. Documentation and presentations to date show that these projects have not been prioritized and funded according to DOE–EM needs, nor that there has been the required "buy–in" by other DOE organizations (EM–30, EM–40, etc.) for this work. DOE should carefully assess the robotics technology needs of *all* DOE–EM organizations, then plan, schedule, and budget for robotics demonstrations and assessments on a needs–driven basis.

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APPENDIX A:

SUBCOMMITTEE REPORTS

SUBCOMMITTEE ON CONTAMINANT PLUMES

Statement of Task

The Plumes Subcommittee was established to assist the Committee on Environmental Management Technologies (CEMT) in identifying the major technological needs in the Department of Energy's (DOE) Plumes Focus Area. Plumes are an integral component of DOE's Environmental Management (EM) strategy. For the purposes of this report, plumes are defined as chemical and/or radiological contaminants exceeding background concentrations in ground water or soil outside an engineered barrier, including landfills.

This report will review the EM–50 assessment of the relative number, size, and importance of various categories of contaminant plumes at DOE sites, and whether remediation of the various classes of contaminant plumes is possible. In addition, the report will identify the most important technology needs regarding containment and remediation.

Scope of Problem and Needs

Currently, DOE is facing the need for cleanup of contaminant plumes at a dozen sites. However, the magnitude of the problem cannot be fully evaluated without a precise functional definition of a contaminant plume and a characterization of each identified plume in the DOE complex, a characterization that would include contaminant concentrations, volume of the affected area, hydrogeologic considerations, and other relevant information. These plumes contain radionuclides, heavy metals, organic compounds, light nonaqueous phase liquids (LNAPLs), and dense nonaqueous phase liquids (DNAPLs) and are the result of historic open dumping, leaking containers, leaking storage tanks, and other precursor events. The greatest challenge to restoration of these contaminant plumes—and indeed, to many current and future environmental and economic challenges—is finding or developing appropriate technological solutions, many of which may not exist at this time. In addition, the subsurface conditions and the physical and chemical contaminant characteristics may be so complex that complete restoration (or cleanup) may not be possible, and thus only isolation and containment may be feasible (NRC, 1994).

In response to this situation, the DOE has formed the Plumes Focus Area to implement effectively its new approach to overcoming major obstacles in the cleanup of DOE sites through environmental research and technology development. According to DOE briefings, the Plumes Focus Area is the closest of the five focus areas to emulating DOE's "new approach" to conduct a research and technology–development program that will address major obstacles in the restoration of their sites. The focus area's current goal is to oversee the environmental research that would result in the development of technologies to (1) contain plumes that pose imminent environmental and health risks, (2) provide significant advances over conventional pump and treat remediation methods, and (3) remediate soils overlying aquifers where contaminants pose a threat to ground water or human health.

The current focus–area goal seems to center on near–term tactical issues such as remediation needs driven by compliance agreements and the commercialization potential of technology. Thus, the DOE–EM's strategic goal for the Plumes Focus Area appears to have been structured too narrowly through the focus on short–term needs and commercialization. This structure does not provide for prioritization of problems based on the number and size of sites or the existing risk, nor on the basis of gaps in existing technology.

The following general recommendations, developed during two meetings of the Plumes Subcommittee, are intended to help DOE–EM improve technology development in the Plumes Focus Area.

Recommendation: The Plumes Focus Area should enlarge its strategic vision to fully embrace the DOE EM's strategic goals for technology development. These broader–based strategic goals are to

- decrease health and environmental risks
- decrease cost of environmental restoration
- enable restoration to proceed, and
- apply resources to the most urgent problems on a priority basis.

These strategic goals are directly applicable to the Contaminant Plumes Focus Area. Part of the challenge in implementing these goals for plume remediation is defining the problem. This problem definition requires an understanding of the

- relative health and environmental risks of the plumes
- sizes and numbers of plumes that are prime candidates for remediation
- costs of remediating the plumes
- capability of available technology to remediate the plumes, and
- prioritization to identify the most urgent problems.

Although the focus area has begun a physical, hydrogeological, and chemical inventory of the DOE plumes, it also should obtain a global view of long–term remediation needs by identifying the major risk and cost drivers associated with their remediation. Solving the technological problems presented by those DOE plumes that contribute most to total long–term risk and cost should be a major strategic goal of the Plumes Focus Area.

Recommendation: The Plumes Focus Area should (1) identify the major risk and cost drivers associated with remediation of DOE contaminant plumes and (2) develop an integrated systems approach to drive technology development that meets the EM strategic goals of risk reduction, cost efficiency, and environmental restoration.

The strategic goal recorded in the *Environmental Management Strategic Plan* (USDOE, 1994) highlights the optimistic goal of reducing plume characterization expenditures by 50 percent by fiscal year 1997. An integrated systems approach might enable DOE to achieve such a cost reduction while still obtaining sufficient characterization data. This goal of reducing characterization expenses also might help meet the overall DOE–EM goals. This recommendation is especially important because numerous contaminant plumes still have not been characterized adequately.

Recommendation: Appropriate internal and external peer reviews of the characterization efforts should be conducted and should become a fundamental part of this integrated systems approach (see Chapter 2, p. 13).

Recommendation: A continuing integrated effort of EM–50 with EM–30 and EM–40 is needed for the Plumes Focus Area to achieve its remediation goals. Also, EM–50 should bring into its technology–development planning some external groups of expertise, including industry and academia, for guidance purposes. Expert or external advisory panels could fill this need.

Although the Plumes Focus Area is working with various stakeholders (from industry, academia, the national laboratories, and other federal agencies) to identify technology needs and to develop technologies, these efforts are not well integrated and often lose focus on the end objective. The intent of this recommendation is to encourage DOE to collaborate more fully with external experts who have a strong interest in achieving such objectives. One particular EM–50 program that has helped to leverage research in this way is the LASAGNA™[6] technology project discussed in the next section. DOE is encouraged to form additional teams of this type to integrate their remediation efforts, both internally and externally.

In–situ Remediation of TCE – A Productive Industry/DOE/EPA Demonstration Using LASAGNA™

Contamination in low–permeability soils poses a significant technical challenge to in–situ remediation. One demonstrated solution to this problem combines electro–osmosis with treatment zones established in the contaminated soils.

The contaminant targeted in an initial field demonstration was trichlorethylene (TCE) at the DOE Gaseous Diffusion Plant in Paducah, Kentucky. The demonstration utilized a process called LASAGNA™. The consortium, known as the Remediation Technology Development Forum (RTDF), which was coordinated by Monsanto, consisted of DuPont and General Electric with participation from the DOE and the EPA. The program was facilitated by Clean Sites, Inc. and implemented by CDM Federal.

Applications and benefits claimed for this process are

- treatment of organic and inorganic contamination, as well as mixed wastes;
- greatly reduced environmental impacts;
- increased cost effectiveness;
- minimal waste generation;
- increased treatment flexibility; and
- broad application for a wide range of sites and contaminants.

Other attributes of this process are rapid technology development and royalty–free use of technology. The Phase I demonstration, completed in the summer of 1995, met and exceeded all expectations for quantitative (mass balance) removal of TCE. Phase II, now in preparation, will involve scale–up and remediation of the Paducah Site.

Recommendation: An assessment of what has been accomplished and learned so far by the Plumes Focus Area is necessary. Each remediation or demonstration should be evaluated to identify successes and lessons learned addressing the questions of what it did and did not accomplish, and why. These lessons learned could be valuable scientific data in charting progress and learning about remediation attempts and could serve as a guide for a future approach. It is important to look at all learning experiences as well as successes, because these experiences have valuable information content. Eventually, good rationale for technology development could be developed, ideally based on both field data and theoretical models.

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[6] The LASAGNA™ technology, a trademark of the Monsanto Company, is a system or combination of components in a configuration of electrodes and degradation zones that permits in–situ treatment of contaminants in low–permeability environments. Monsanto Company has coined the word LASAGNA to identify its products and services based on this integrated in–situ remediation technology.

Cleanup Objectives

Cleanup goals are an integral part of evaluation of appropriate technologies, remediation costs, and even feasibility of remediation. Goals often are set by regulations and typically are defined in terms of concentration of contaminants in the ground water or soil after remediation is complete. However, such cleanup goals can be elusive if the technical capabilities of existing and emerging technologies are not considered. For example, for most sites with complex hydrogeology and chemistry, attainment of current drinking–water standards generally is not possible with conventional technologies nor has it been demonstrated adequately with emerging technologies. The limitations of existing technologies, the implications of current cleanup standards, and alternative approaches to setting cleanup goals were discussed in *Alternatives to Ground Water Cleanup* (NRC, 1994). Risk–based goals, that result in site–specific cleanup goals, are alternatives that are receiving consideration by many agencies throughout the country. Technical impracticability issues also must be considered.

Recommendation: DOE should establish a process for developing specific cleanup goals for each of its contaminated sites, because the appropriate approach for remediation of a site depends upon the cleanup goals, intended land use, and technical practicality issues.

Recommendation: DOE should compile an inventory of the scope (size and type) of contaminant plumes including thorough documentation and quantitative evaluations of risk and costs posed by these plumes. Major technological needs to address high–risk and cost sites should be identified in this process. It is important to stress that setting priorities rationally is not possible until a problem is defined.

Criteria

The selection of end points in remediation is integral to technology development. How much technology development is done (characterization, containment, and remediation) depends on the criteria or end points that are established.

The use of relevant criteria by which to characterize, contain, and remediate contaminant plumes, and the uses of risk and cost trade–offs were addressed by the subcommittee. During briefings, EM–50 indicated that their technology–development strategy is based on a three–step approach: containment of the biggest contaminant risks, treatment of ground water, and then treatment of soil contamination (which is considered a longer–term threat). The Plumes Focus Area technology–development strategy is driven by matching technology to EM needs using a Decision Analysis System to guide the process. The Decision Analysis System matches available or emerging technologies from government and industry with EM site problems and demonstrates where current technologies can provide solutions and where technology gaps exist. A problem is that the sites frequently do not have the information DOE needs to help make these kinds of decisions.

Recommendation: EM–50 should complete quantification and prioritization of the contaminant plumes in the DOE complex.

Status of Current Technologies and Needs

According to EM–50 briefings, numerous technology–development/application activities are on–going throughout the DOE complex. These efforts are organized into four areas: (1) site assessments, (2) contaminant characterization, (3) treatment technologies, and (4) containment technology. Methods for measuring aquifer properties, on–line remediation process controls, and subsurface exploration and access tools are under development to improve site–assessment approaches. Closely associated with these efforts are programs to characterize DNAPLs and other contaminants using noninvasive techniques. In addition, significant efforts are being directed toward identification of in–situ treatment of plumes to minimize worker and public exposure, waste generation, and costs. Coupled with the in–situ treatment technology focus are efforts to implement effective, reactive barriers for containment of the plumes. In addition, EM–50 is evaluating technologies that have application across three key research areas, such as robotics technology; characterization, monitoring, and sensor technology; and separations technology.

Although these areas of technology development are numerous and are being pursued with great vigor and energy, the Contaminant Plume Subcommittee presently is not able to judge the appropriateness or progress of the program without additional information. This needed information consists of quantification and prioritization of the contaminant plumes in the DOE complex. Once this information is assembled, a more realistic assessment can be made regarding the effectiveness, appropriateness, and timeliness of current research activities, as well as major technology needs in the Plumes Focus Area.

Recommendation: Tools to locate DNAPLs, as well as in–situ sensors to reduce burdensome laboratory costs, should be developed and/or refined. These efforts must be coordinated with other entities (both internal and external to DOE) that are performing similar activities.

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SUBCOMMITTEE ON LANDFILLS

Overview and Summary of Preliminary Recommendations

Overview of Subcommittee Activities and Approach

Because of its brief exposure to DOE landfill technology–development efforts during its two meetings in 1995, the subcommittee feels that both its findings and recommendations must be considered preliminary. In addition, the subcommittee accepted as its charge for 1995 to make only constructive recommendations that can be implemented by the Landfills Focus Area in the short term. Preliminary observations and recommendations presented in this overview and summary have been selected from the body of this report, which contains the rationale and more detailed discussion of each observation and recommendation.

Observations and Preliminary Recommendations

1. Reorganization of DOE technology development into focus areas is a positive development. The Landfills Focus Area has moved aggressively to implement departmental guidance, and there is clear evidence that initial efforts have been successful. The focus area technical team demonstrates a high level of *esprit de corps* and willingness to engage in cooperative R&D between laboratories and sites.
2. Greater effort in long–term performance testing and monitoring of engineered containment techniques and systems, including covers, caps, barrier walls, and floors, is encouraged.
3. If the Landfills Focus Area receives adequate and stable funding, it is probable that DOE will be able to meet its needs to develop better technology.
4. A problem–solving orientation in technology development is advocated.
5. A ranking/categorization for landfill–related problems based on relative risk would be useful to drive technology development in DOE. These analyses need not use sophisticated models and may already exist to some degree in DOE literature. Technology needs determined by this risk prioritization process would establish technical tasks. These technical tasks would then be organized into technology–based

product lines, rather than the waste–type and climate–based product lines as they are organized currently. The proposed technology grouping would include five product lines:

(1) characterization,
(2) retrieval,
(3) treatment (including both in– and ex–situ methods),
(4) containment and monitoring, and
(5) systems integration and design.

6. The technology–development program in the Landfills Focus Area would benefit greatly from a critical on–going assessment of the efficacy and efficiency of technologies already developed both inside and outside DOE. Recent work in assessing the state–of–the–art in relevant technical areas addressing DOE's priority needs is supported, and an increased level of effort in this area is needed. The desired goal is to establish DOE's niche in environmental technology development by focusing DOE–EM's efforts in technology development into areas of need not well supported outside of the department.

7. Each technical project would benefit from clearly established goals and a strategic plan to guide development. An action plan describing how strategic goals are to be met should be part of an assessment of field applications. The subcommittee is strongly supportive of "gate" reviews and believes that the gate–review concept would be helpful in R&D planning (see discussion of gate reviews in Chapter 3, page 19).

8. The Landfills Focus Area should be proactive in working with regulatory agencies to establish criteria that will promote regulatory acceptance of appropriate landfill remediation technologies. Also, agreed–upon means for establishing targeted cleanup levels would serve as useful guides to technology–development activities. The subcommittee does not challenge the notion that cleanup levels should be site specific.

9. Increased effort in performing project peer reviews (for example, the EM–50 Project Review [TTP No. SF201101] of In–Situ Microbial Filter Project by the Plumes Focus Area, June 6–7, 1995) by external technical experts who have been rigorously screened for conflict of interest is strongly encouraged. Such peer review could take place at a particular "gate" of the DOE–EM technology maturation model, or at highly focused workshops where related technology projects are assessed.

Preliminary Findings, Observations, and Recommendations

Scope of DOE Landfills Focus Area

The Landfills Focus Area has defined its scope as that of technology development appropriate for DOE landfill needs. Improvements in technical methods are sought in each aspect of remediation. The stages of remediation include assessment (or characterization of both sites and buried waste), selection of one or more treatment options, design of the remediation system, implementation of the remediation plan, and post–monitoring (as appropriate) to confirm risk abatement. Remediation options for landfills include

- excavation (or retrieval), with the generation of a waste stream destined for above–ground storage and/or ex–situ treatment;
- containment, as with barriers;
- in–situ stabilization, as with an injected grout or in–situ vitrification, and
- in–situ remediation, using physical, chemical, and/or biological techniques.

Because of the magnitude and variety of DOE landfill problems (with an estimated three million cubic meters of buried waste in landfills nationwide, in a variety of climates and hydrogeological settings), it is anticipated that each of the above–mentioned remediation options will find application somewhere in the DOE complex. The Landfills Focus Area, with an annual budget between $30 and $50 million, has supported work in Fiscal Years (FY) 1995 and 1996 in the areas of assessment, retrieval, containment, in–situ stabilization, in–situ remediation, and ex–situ treatment.

Overview of DOE Landfills Program and Focus Area

The Landfills Focus Area has begun an ambitious program of facilitating technology development. Several clearly defined roles or program elements can be identified.

1. *The focus area awards funding to R&D projects that have technical merit and contribute to program goals.* For organizational purposes, these projects have been grouped into four areas, called product lines, each overseen and coordinated by a separate program manager.
2. *Based on strategic plans developed within DOE–EM, the Landfills Focus Area has undertaken strategic planning activity* (USDOE, 1994).
3. *Assessment of state–of–the–art practices in relevant technical areas.* Examples of information gathering activities include the *International Containment Technology Workshop* (August 29–31, 1995, in Baltimore, Md.), the *TRU (transuranic), TRU Mixed, and Mixed Low–Level Waste Treatment Technologies Technical Peer Review* meeting (November 13–15, 1995, in Dallas, Tex.), and the *Non–Destructive Assay and Non–Destructive Evaluation (NDA/NDE)* workshop (January 25–26, 1996, in Pittsburgh, Pa.). Another example is the technical "bakeoff" demonstrations, such as the Very Early Time ElectroMagnetic (VETEM) demonstration planned at Idaho National Engineering Laboratory (INEL), where

competing technical methods and systems can be compared by their performance on a common test bed.

4. *Interaction with technology customers within DOE.* Interactions with stakeholders and EM–40 site managers have occurred through the Site Technology Coordination Groups (STCGs) and through the efforts of the External Integration Team. An end user is required of all projects funded beyond "gate four" of the R&D technology maturation model developed within EM–50.

5. *Interactions of the focus area's industrial team with commercial and industrial organizations to assess what to buy outside of DOE versus what to develop in–house.* This work includes market assessment and the development of commercialization or business plans for DOE–developed technologies.

6. *Performance of technology demonstrations on DOE sites.* Interaction with technology developers and a site selection process are involved.

The Subcommittee on Landfills endorses the new approach to DOE technology development begun in 1994 with formation of the focus area structure, and the work of the Landfills Focus Area in their efforts to implement this new approach.

Strategic Planning, Programmatic Goals, and Performance Measures

A problem–solving orientation for technology development is advocated. The development, demonstration, and implementation of environmental remediation technologies should be focused on the problems of the DOE sites. Implementing a problem–oriented technology–development plan encompasses the following:

- problem identification and prioritization;
- identification of the technology needs to control, eliminate, and/or minimize the risk that established the problem;
- establishment of goals tied to a strategic plan to track technical progress toward problem solution; and
- restructuring of the organizational product lines to focus on problem solving, with the establishment of an additional Systems Integration and Design Group.

A problem–solving orientation requires that the problems be ranked according to risk, forcing the earliest attention on the problems whose solutions yield the greatest benefit. It also avoids the criticism that the easiest, least important problems are the first ones examined and solved. However, the time required to solve the problem also should be considered when determining technologies appropriate for the solution. Ranking the problems according to risk requires the definition of risk, the human or environmental component at risk, and the time frames of concern for the risk. For example, the risk measure may be 100 mrem/yr to critical members of the population after 300 years of site control. The risk measure also may be inferred by indirect criteria such as the drinking–water limiting concentrations to potential potable water sources off–site.

The data needed for a risk determination may not be available, highlighting the need for proper characterization of each problem, particularly the inventory and contaminant characteristics. However, sufficient data on the critical parameters should be available for a preliminary evaluation of risk sufficient for ranking. A complete characterization is not required to evaluate reasonably the risk ranking for landfills.

The next step involves determining the contaminant inventory and characteristics, the potential pathways for contact, and the critical pathways for the potential exposures. These pathways then must be characterized, and the appropriate models for the risk must be selected. The model need not be sophisticated for the purpose of ranking the problems.

Regulatory Aspects Impacting the Landfills Focus Area

One way to view landfill–remediation needs is to understand the regulatory requirements for legal closure at a landfill site. Any existing or potential releases of hazardous chemicals and/or radioactive waste to the environment makes a site eligible for consideration in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Superfund Amendments and Reauthorization Act (1986) (SARA) process, among other Applicable or Relevant and Appropriate Requirements, (ARARs).

These ARARs, including CERCLA/SARA legislation, allow for Removal Actions. Where there is a threat to public health or welfare or the environment, Removal Actions, whether Time or Non–Time Critical, can be implemented. Removal Actions shall, to the extent practical, contribute to the efficient performance of the anticipated long–term remedial action. For some landfills of interest here, this categorization is possible and currently is practiced by another federal agency (the Department of Defense) to expedite site remediation.

If Removal Actions are not appropriate, the full CERCLA process on a relevant Operable Unit is then invoked, involving a period of investigation that results in a Remedial Investigation/Feasibility Study (RI/FS), followed by the signed Record of Decision (ROD), containing the legally agreed upon remediation method.

Flexibility is built into some RODs, allowing attempts at alternate solutions for trial periods typically lasting approximately one year (see, for example, Soelberg et al., 1995). However, the schedule of ROD signings dictates the end of the period during which various remediation scenarios are debated most fully. The use of a new technical method would have to be advocated prior to the ROD signing. The bulk of technology development is then necessary prior to the ROD. The schedule of RODs acts as a significant time constraint on the implementation and use of results of R&D work products.

For other regulatory processes, similar considerations apply. For landfills under local regulation, a new technology advocated for use would have to gain acceptance by local regulators. Those technical methods that have achieved a greater level of maturity, testing, and history of successful application would naturally be favored.

Recommendations:

1. The Landfills Focus Area should be proactive in working with regulators on landfill remediation. Consultations to date with the EPA are supported, and it is hoped that such continued interactions with representatives of regulatory agencies can produce remediation choices and designs that enjoy widespread acceptance[7].

2. Field demonstrations of appropriate technologies can enable the granting of Removal Actions and garner local regulatory support. The focus area should try to ensure that demonstrations affect this process in a positive manner. CERCLA Removal Actions are less costly than the full RI/FS process that involves more extensive characterization studies.

3. Regulatory acceptance is an important issue. A regulator or regulatory body's yes/no (go/no go) decision to try an emerging remediation technique can translate directly into the worthiness of the requisite technology development. In general, only technologies at a sufficiently mature level of development will be able to undergo a credible field test demonstration and be considered seriously for regulatory approval. Because this maturity occurs at the end of development, the development costs are undertaken with some risk. Regulators have been described as reluctant to participate in technology development, or to endorse a technical method, prior to its full development, and such caution is understandable. Technology developers can be frustrated not knowing whether technical progress will translate into the regulatory acceptance required for deployment. Technology seminars with state and local regulators would help expand their knowledge of the applicability of new and existing remedial technologies. Presenters at these seminars should include experts from within as well as outside DOE.

The straightforward answer to this situation is to have technical *criteria* established that serve both state and local regulators. The Landfills Focus Area should establish criteria that satisfy the relevant regulations and serve as guidelines for technology development. To help facilitate interactions of the focus area with regulators and developers, the focus area should disseminate the criteria broadly, especially within DOE, EPA, and state regulatory agencies.

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[7] Briefings to the Subcommittee on Landfills by DOE–EM 50 personnel and Subijoy Dutta of the U. S. EPA.

Status of Current DOE Environmental–Technology Projects

The Digface characterization project being developed by the Idaho National Engineering Laboratory (INEL), Ecology International, and Rust Geotech Inc., is an integrated demonstration of multiple sensors that can be used as part of a retrieval effort. The Digface characterization technology will allow continuous and continually improving monitoring and characterization of the site being remediated. The Digface characterization excavation system is useful and fills a needed role of providing characterization information beyond the limitations of present nonintrusive techniques. (For a list of FY 1995 projects, see USDOE [1995 a, b]).

The issue here is the adequacy of existing information (from historical records and from characterization studies done with current methods) in providing a sufficient waste and site assessment for remediation planning purposes. The question is raised whether present technical methods can supply this information adequately, without costly drilling and sampling. An example of a significant omission with present techniques is an underground storage tank at Fernald that was not discovered during site characterization; its later discovery required adjustments to the remediation strategy. The Digface system seems to provide a technical approach to proceed with available information, and with the flexibility to acquire more information and make decisions as the excavation proceeds.

The projects cited below are examples of work whose rationale for development does not seem to be on a sufficiently firm basis to be treated as priorities. Items 1, 2, 4, and 6 are developed technologies and item 3 has a doubtful success probability in the short (2–5 years) term. Success is needed for containment in situ, which should remain a development priority along with monitoring methods. Item 5 is a temporary fix in an arid environment. The short–term benefit from air drying of a coarse–grained cover layer does not outweigh the cost of the technology.

1. Alternative Landfill Cover Demonstration (LLW/Arid). The proposed project area generally is considered to be a developed technology, and facilities currently are using the ideas. One example is the radon barrier and cover field test at Grand Junction, Colorado, multiyear field test conducted over several years. Another example is the multilayer earthen cover system planned for the Low–Level Waste Disposal Facility in North Carolina.

Although the program is currently conducted in an arid environment, it should take place in a humid environment, which is the more critical use for multilayer covers.

This project also needs mass balance data (supporting a relation such as In(precipitation) = Out(evapotranspiration + capture/collection) at an appropriate site to evaluate effectiveness.

2. Design of Capillary Barriers (LLW/Arid). This project area is well developed, including computer codes to predict capillary performance. Capillary barriers are being used in covers, and they have also been designed and proposed in covers over commercial LLW disposal facilities. An example is the multilayer earthen cover system planned for the California Low-Level Waste Disposal System. It has a capillary barrier that also functions as a biointrusion barrier. Again, the capillary barrier program should be conducted in a humid environment.

3. Subsurface Barrier Emplacement (Grouts) (LLW/Arid; LLW/Non-Arid). DOE sites have worked on this project area for decades. In-situ grouting has met with limited success and is not used commercially because integral barriers have not been achieved. It is also difficult to determine in the short run if a grout barrier under a landfill maintains full integrity. Short-run success is doubtful for this area. The technology is not in the technology-development stage, but is in the research stage. Better testing methods to evaluate barrier performance are also needed.

4. Radon Mitigation and Monitoring at Fernald. Techniques have been developed for mitigation and monitoring of radon in the environment. This project sounds more like a site application test than a technology-development test.

5. Dry Barriers for Covers (LLW/Arid). This project may reduce moisture in earth covers in arid environments. However, it is an active process that is a temporary solution at best.

6. Tracers to Determine Transport Processes in the Vadose Zone. Tracers have been used to determine water and gaseous flow in geologic media for several years. Most geohydrologists believe that transport processes are well understood but are not easy to monitor quantitatively. Field experience, modeling, and testing of vadose zone transport have established a suitable technical basis for design and implementation.

7. Thermal Enhanced Soil Vapor Extraction. This technique has been demonstrated (Cox et al., 1995; Gopinath and Germar, 1995; Strzempka et al., 1995) commercially using more cost-effective methods than DOE's electrode-type heating probes.

State-of-the-Art Assessment of Environmental Technologies

The Landfills Focus Area should identify clearly those technologies needed to address specific site-related problems, including an assessment of the state-of-the-art technologies that have found application to similar problems both inside and outside of DOE. This assessment involves locating and referencing relevant resources and centers of expertise, with a goal of establishing the unique niche or role of DOE in technology development.

Projects included in the 1995 technology-development program (USDOE, 1995a) focus on the demonstration of a wide variety of technologies, not all of which are uniquely attributable to DOE research and development. Indeed, DOE has not played a significant role in the development of some of the technologies counted as "successes" or work products. In other instances, technology development has not been clearly focused on the technology needs for solving specific problems. Past program plans sometimes have neglected critical assessment of state–of–knowledge in project–related areas and do not show evidence of leveraging DOE efforts with existing centers of expertise. Specifically, DOE technology–program plans do not establish clearly DOE's niche in contributing to the development of those technologies that are already the subject of broad–based research and development efforts elsewhere.

Implementing technology demonstrations is a significant part of the Landfills Focus Area activity, and such demonstrations need not necessarily come from in–house development. In briefings to the subcommittee at the Savannah River Laboratory, the FY 1996 program for technology development in the Plumes and Landfills focus areas demonstrated greater knowledge and outreach. It is hoped that a technology–based focus area approach for problem solution will help foster further development of the context in which the DOE technology program exists.

To this end, the focus area should engage in outreach activities that seek out the best in each technical field. One aim of this effort is to provide the rationale for the technology–development activity that is sponsored within the agency. Another aim is to engage peer review input.

DOE headquarters has made efforts to work with other agencies and private sector vendors, such as the recent co–sponsoring of the August 1995 *International Containment Technology Workshop* in Baltimore, Md., by DOE, EPA, and DuPont (USDOE et al., 1996). The invited speakers included representatives from abroad and from a host of institutions, including industry, the USNRC, and universities. This effort of soliciting broad–based input for technical issues in barrier technology is the kind of activity required to develop the rationale for the DOE program in barriers. Input on state–of–the–art practice, a sense of technical needs, and ideas for what methods are most suitable for deployment in DOE are the kinds of information that are needed to establish an understanding of the technical–development program. Specifically, the policy–related findings of this workshop should be established and recorded. The plan to convene a more rigorous follow–up public conference in the near future (early 1997) is supported.

Similar information–seeking efforts conducted by the Landfills Focus Area in late 1995 also are supported. These include the transuranic *(TRU), TRU Mixed, and Mixed Low–Level Waste Treatment Technology Technical Peer Review* meeting (November 13–15, 1995, in Dallas, Tex.), the *Non–Destructive Assay and Non–Destructive Evaluation* workshop *(NDA/NDE)* (January 25–26, 1996, in Pittsburgh, Pa.), and the Very Early Time Electromagnetic (VETEM) technical demonstration (scheduled for late 1995 at INEL). This approach for key technical areas of importance in landfill remediation strategy is endorsed.

A key decision emerging from this process is the determination of the technical areas in which DOE wants to have in–house, first–rate expertise. This process involves deselecting some technical areas in ER where external expertise can then be called in, perhaps in a subcontractor role, and in which DOE can view itself as a customer.

Barrier and Cap Technology

The integrity and long–term performance of cap and barrier walls are issues worthy of further work that is focused in certain areas of need. These issues are discussed below. Although caps can be successful (as shown by archaeological analogs in burial mounds) present designs have exhibited shortcomings, mainly through biointrusion of both animals and plants. However, little is known at present about long–term performance of presently engineered barrier walls and caps. Arguably, the most long–term data on present cap design are on vegetated caps, installed in the mid–1980's (Schulz et al., 1995); the DOE Hanford Site Permanent Isolation Surface Barrier work (Cadwell et al., 1993); and the DOE Uranium Mill Tailings Remedial Action Program (UMTRAP) work (Zellmer, 1981; Simmons and Gee, 1981; Gee et al., 1984; Mayer et al., 1981a; Cline et al., 1982; Voorhees et al., 1983; Beedlow, 1984; and Mayer et al., 1981b) done in the late 1970's and early 1980's. The subcommittee heard from several researchers and practitioners that long–term data on barrier wall performance are also a significant need[8] (USDOE et al., 1996; ER'95, in press). To collect such data, a limited program of long–term performance assessment of barrier walls and caps is recommended, because these are key components of present DOE Environmental Restoration (ER) strategy[9]. It can be argued that every barrier wall, or a representative sample of them, should be monitored over the design lifetime.

A program for monitoring long–term performance is suggested, in part because of current limitations of verification and monitoring techniques (Heiser, 1994). For an example of a testing and monitoring plan, see Gee et al. (1993). The work should not repeat previous studies of this type; rather it should have a clear objective with specific outcomes, and it should be focused on humid, not arid sites.

The reason for such a monitoring effort is that caps and barrier walls are not a proven permanent isolation technique. Their failure depends upon imperfections and nonidealities in installation and on material properties. For a discussion of failure mechanisms and construction quality assurance and control, see Rumer and Ryan (1995). The subcommittee has heard from practitioners that present field installation methods make guaranteeing integrity difficult. Pathways for leaks can be produced by mechanical stresses at interfaces, during installation or due to underlying strata. Present materials (grout, slurry, and plastics) possess finite leachability and conductivity parameters that do not guarantee long–term environmental isolation.

One suggestion is to perform field studies on existing DOE–UMTRAP caps, which were designed to last 1000 years, in compliance with regulations. The Cannonsburg, Pa., site is a candidate for humid–area studies.

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[8] Briefing to the Subcommittee on Landfills by Professor David Daniel of the University of Texas at Austin, July 20, 1995, Washington, D.C.

[9] Remarks of John Lehr at *Barriers for Long–Term Isolation Workshop*, on in–place actions envisioned within the Office of Environmental Restoration (EM–40) throughout the DOE–EM complex; ER'95, 1996.

Technical–Needs Assessment Studies

An ongoing and more extensive system of needs assessment is encouraged. Part of this assessment involves dialogue with EM–40 customers, which the focus area has begun and which should continue. Another component of this assessment involves a comparison between the results of expected environmental transport mechanisms (including the ultimate fate of the contaminants) and the proposed plans to assess the long–term adequacy of the proposed remediation methods. Such comparisons also should be continued. One way to do this is to compare two technical studies. The first is a study to assess the leachability of materials in present DOE landfills, and the methods used to assess long–term leachability characteristics. This work would be useful for establishing DOE "waste acceptance criteria" for future waste designated for landfill disposal. Long–term leachability characterization also should assess differing climate conditions.

The second is a study (see, for example, Siskind and Heiser, 1993; Heiser and Milian, 1994) to assess the materials used in stabilization and containment methods. Such a study should include information on hydraulic conductivity, permeability, long–term integrity, and application considerations under varying source conditions. Work that tracks the progress of technical work in this area can be used as a reference to establish DOE criteria for selecting both the material and the method of application.

The results of these two studies should establish knowledgeable estimates on the relevant time scale and degree of containment achieved by containment and stabilization methods.

Performance Measure Modification

Program performance measures (USDOE, 1994), a management tool designed to facilitate a problem–solving approach, should be modified as necessary to measure factors that reflect desirable working relationships. Specifically, a record should be kept of the number of challenging technical and environmental problems that are solved, and such a count should be given greater weight in assessing the program than the presently used performance measures for EM–40 and EM–50. Higher–risk problems should be given correspondingly higher weighting factors.

General Guidance and Subcommittee Perspective

The preliminary recommendations outlined above have been given with the intention of

- retaining the practice of sound environmental science and technology in DOE's landfill remediation work,
- establishing implementation techniques that provide long-term protection, and
- developing methods to monitor the long-term effectiveness of landfills, to the extent possible.

To guide its work in technology development, DOE's program should interact with, draw from, and support the best of research and application activity in appropriate disciplines.

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SUBCOMMITTEE ON HIGH–LEVEL WASTE IN TANKS

Introduction

The Subcommittee on High–Level Waste in Tanks was formed in the second half of 1995 and has held two meetings. On the basis of the information obtained during those meetings and coupled with the experience of the members, this report is a preliminary assessment of the issues pertaining to technology needs for the disposition of radioactive waste in tanks. The approach was to comment on the technology issues and needs relative to the current approaches being taken for remediation of the tank wastes by DOE and its contractors. Prior to discussing technology needs, a limited amount of background information is provided based principally on *Radioactive Tank Waste Remediation Focus Area* (USDOE, 1995a).

The high–level waste tank issue has to do with the safe management of over 100 million gallons of radioactive wastes in 332 underground storage tanks distributed among five sites. The five sites are Hanford, Savannah River, the Idaho National Engineering Laboratory (INEL), Oak Ridge National Laboratory (ORNL), and West Valley, New York. Of the 332 tanks across the complex, 177 are located at Hanford, which contain over 60 percent of the DOE tank waste (USDOE, 1995b).

The waste in the 332 tanks is in the form of sludge, supernate, and saltcake. The wastes at the five sites differ in quantity, age, storage mode, originating process, chemical composition, and physical attribute. In most of the tanks, the wastes, originally formed as acidic solutions of radioactive nuclides, are now in a strong basic medium and hence have various solids associated with the caustic supernate. In addition, some sites have processed some of the wastes to concentrate the solutions and reduce the volumes, resulting in crystallized components of the waste also being present in tanks. Finally, some of the wastes were formed during processing of the original source of waste to remove selected components by processes that differ from those that formed the waste. In short, wastes in the tanks are a heterogeneous mixture of solutions, sludges, saltcakes, and other phases.

Some of the tanks have leaked, and the ability of a significant but unknown number of tanks to confine the liquid phases has been lost. Further, some of the tanks have generated combustible gases leading to the potential of conflagrations or explosions. The current practice at all sites is to manage the safety issues on a high-priority basis. Processing for the final disposition of the contents of the tanks is being implemented at only two of the sites, the Savannah River Site/Defense Waste Processing facility (SRS/DWPF), and the West Valley Demonstration Project (WVDP)[10]. It is likely that at all of the sites, several types of actions using existing technologies will take place as discussed in the next section and highlighted in Figure 1. The report focuses on the identification of those technology needs that appear to be pertinent, generally, to the five sites currently holding such waste. These sites, i.e., Hanford, Savannah River, West Valley, Oak Ridge, and the Idaho Chemical Processing Plant (ICPP) are in various stages of developing processes and facilities for the conversion of waste in tanks to stable forms of high-level waste (HLW) and low-level waste (LLW)[11] (Westinghouse Savannah River Company, 1994; Priebe and Valentine, 1980; Gephart and Lundgren, 1995; INEL, 1994).

Technology pertinent to the management of the waste in tanks will include all processes, operations, and facilities used in the conversion of material in the tanks to the desired end products, including disposal of the tanks. The subcommittee has not been provided with, nor has it obtained a comprehensive catalog of the current activities of the various departments of the DOE that are pursuing the development of technologies related to the management of wastes in tanks. The subcommittee has obtained information on parts of some of the programs pertinent to waste in tanks, and members of the subcommittee have had access to information related to such activities. Nevertheless, this report should be considered preliminary. Finally, this report will not include details of technologies pertinent to the management of waste in tanks, but rather will address the general issues posed by these wastes and the planned management strategies. Future reports of the subcommittee will reach beyond the "planned" strategies and take a scenario approach to identifying technology needs. This approach is briefly discussed in the following section.

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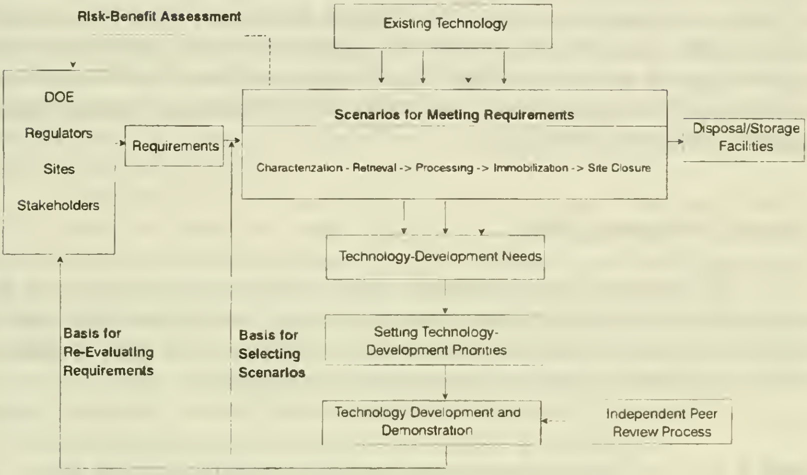
[10] With respect to the Defense Waste Processing Facility, some safety aspects are not yet fully resolved in all the steps of the process. The result is that "hot" startup has been postponed until approximately March 1996. With respect to West Valley, following a leak in the melter, a review team identified the need for several improvements in the operation of the process equipment. Operations have been delayed until all improvements are implemented.

[11] In some cases, these designations may not be entirely appropriate but are used here to designate waste that is highly radioactive and hazardous (HLW) and waste that is much less radioactive and generally much less hazardous (LLW). Since there is not now an accepted definition of such wastes based on their hazard, the definitions of HLW and LLW currently in use will be maintained.

FIGURE 1: RELATIONSHIP OF TECHNOLOGY DEVELOPMENT TO WASTE REMEDIATION


Risk-Benefit Assessment
Existing Technology
DOE
Regulators
Sites
Stakeholders
Requirements
Scenarios for Meeting Requirements
Characterization - Retrieval -> Processing -> Immobilization -> Site Closure
Disposal/Storage Facilities
Technology-Development Needs
Setting Technology-Development Priorities
Technology Development and Demonstration
Independent Peer Review Process
Basis for Re-Evaluating Requirements
Basis for Selecting Scenarios

Scenario Approach

It is the subcommittee's intention to emphasize what the scenario evaluations indicate as the overarching needs and issues that directly affect many components of technology development and indirectly affect all aspects of tank waste remediation. The subcommittee chooses a scenario strategy (i.e., how the subcommittee will conduct its investigations, not DOE strategy) as the best way to address overall technology issues and needs. The subcommittee will seek to distinguish between site–specific issues and issues applicable to multiple sites.

Figure 1 is an attempt to diagram the relationship of technology development to the disposition of radioactive waste in tanks. The figure is very conceptual and is not an attempt to depict the details of what actually happens. Furthermore, some of the steps are yet to be defined, such as the peer–review process and the use of risk–benefit methods to prioritize the scenarios. For the case of high–level waste in tanks, the range of scenarios and end states might vary from the "no–action" scenario (perpetual surveillance and maintenance), and containment–in–place scenario (stabilize tank contents and tank forms), to scenarios that would lead to vitrified waste for disposal and a pristine site. Of course, all the in–between states involve different degrees of clean up. Except for the "in–place" scenarios, the sequence of events comprising the scenarios would consist of such activities as waste characterization, retrieval from the tanks, processing, immobilization, site closure, with differing technology–development needs. The result would be a clear display of the technologies involved, including those that are developed and available as well as those needing development. The task then becomes one of assessing the scenarios against the chosen set of performance measures leading to the identification of technology–development requirements. Candidate performance measures are safety of the workers and public, cost and schedule, public acceptance, environmental and economic impact, and technical feasibility. Prioritizing a scenario at this early stage will most likely be done against a much smaller set of performance measures such as safety and regulatory acceptability.

Common Technology Needs

Evaluation of the presentations made and DOE documents led to the conclusion that there are significant common technology–development needs related to the management of high–level waste in tanks. These needs are listed in Table 1 and are preliminarily ordered in decreasing order of importance.

TABLE 1: Technology–Development Needs for Managing High–Level Waste in Tanks that are Common to All Sites[12]

- Waste characterization.
- Final disposition of tanks containing residual waste.
- Retrieval of multiphase wastes from tanks with access limitations.
- Vitrification of wastes, including off–gas treatment and recycle of volatile radionuclides.
- Removal of Cs from supernatant, dissolved solids, and secondary wastes.
- Disposition of used melters.

Both Savannah River and West Valley have progressed in the development of processes and facilities for the treatment of wastes in tanks. Both sites plan to produce HLW glass and process the associated LLW wastes into grout during 1996. For these operations, the technology needs will focus on the final steps of the remediation process, namely the final disposition of the tanks and the residual waste in them. The subcommittee could not determine criteria from any site for the allowed residual waste in tanks or a general outline of plans for the final disposition of the tanks themselves after the remediation process. There could be significant technology–development needs when such decisions are made, because it is likely that complete removal of waste from the tanks is impractical and confinement of residue in the tanks for prolonged periods will be a requirement. Further, if complete removal of the tanks becomes a requirement, it is clear that considerable development and testing of techniques will be required.

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[12] The commonality of these needs to the Idaho site may be limited because of significant differences in the nature of the waste and the proposed management approach (i.e., acid dissolution).

All of the sites have elected to produce a form of glass as the waste form for HLW. While the details of melter design, size, operation, expected life, and maintenance may be different among the sites, in all cases the melter off–gas system will be an important part of the process. The subcommittee believes that technology to recycle the expected volatile components of the melter feed, with particular attention to some of the radioactive materials in that feed, will need to be developed and tested. Further, the disposition of massive highly radioactive melters that are no longer functional or have been subjected to unplanned incidents may require technologies that are not yet available and will need to be developed.

Due to the differences in the compositions of the wastes, processes to effect required separations may be somewhat different among the sites. However, removal of multiphase waste from tanks in various states of disrepair will be an activity at all sites. While both Savannah River and West Valley apparently have produced satisfactory waste removal systems, such is not the case for Hanford and Oak Ridge. The waste at Hanford appears to be particularly recalcitrant in that aged sludge, saltcake, and supernate solution may be present in a single tank. The subcommittee concludes that techniques for the retrieval of tank contents, especially in light of the potential for many single–shell tanks to have leaks of radioactive liquids, are a common technology need.

The common needs listed in Table 1 are directed primarily at the four DOE sites that have alkaline nitrate supernatant–salt–sludge wastes in tanks. While technology developed at or for one site may not be entirely applicable to the needs at another site, the subcommittee expects that there will be substantial commonalties that point to the need for an integrated technology–development program. The technology–development needs at the Idaho site will be significantly different because the wastes, the bulk of which are now present as solids, will be dissolved into acid solution as opposed to the alkaline wastes at other sites. There is significant European experience with processing and immobilizing acidic wastes that may be relevant, although the Idaho wastes are expected to have much higher sodium, aluminum, and fluoride content than those in Europe.

It is recognized that there may be other potentially common technology–development needs and that numerous site–specific technology–development needs also exist. Technology–development activities related to all of these should continue to be integrated by an entity such as the Tank Focus Area.

Specific Technology Needs

The subcommittee has not had sufficient time to evaluate site–specific technology–development programs and believes that broader issues discussed herein should take precedence. Therefore, no specific delineation of such needs will be made until the subcommittee has had a better opportunity to examine the various programs in more detail.

Major Concerns

A number of concerns that profoundly affect the technology–development efforts depicted in Figure 1 are given in Table 2. These issues are thought to be inadequately addressed relative to the needs of the technology–development program. However, the information gathered thus far is not sufficient to state this as a conclusion.

Some of the concerns (e.g., undefined end points, technology–development needs in a privatization scenario, and trade offs) in Table 2 define the boundary conditions for technology development and thus the nature and extent of technology development. The other concerns are more directly related to defining how much technology development is enough (or too much). If present approaches prevail, endpoints will be established by joint agreement among the cognizant DOE field office, the cognizant EPA, the host state, and possibly, Native American tribes. However, it is clearly within DOE's authority and ability to examine the history and trends in end points (i.e., waste–acceptance criteria) and establish moderately conservative interim end points that will provide a consistent focus for technology development.

TABLE 2: Major Concerns Affecting Development of Technology for Managing High–Level Waste in Tanks

- Performing technology development when the end points (especially waste acceptance and tank–disposition criteria) are changing or unspecified, or when unrealistic requirements are imposed.
- Technology–development needs in a privatization scenario.
- The necessity and desirability for vitrifying low–level waste.
- Accommodating top–level tradeoffs (a) between the need for technology development and cost, schedule, and performance; and (b) between the performance requirements of major process operations such as characterization and pretreatment.
- Determination of the extent to which technologies developed and validated at a particular site are applicable to other sites and wastes.
- The need to perform technology–development work using actual wastes, i.e., the relevance of work performed using simulants.

These concerns are important to the extent that (a) the subcommittee will focus on them as areas to be evaluated as it obtains data from DOE tank sites, and (b) DOE–EM should consider explicitly addressing them to provide the necessary framework for technology development.

Conclusions and Recommendations

Conclusion: Substantial technology–development needs remain to be addressed if high–level waste tanks are to be successfully remediated.

Recommendation: The DOE should continue to support a balanced technology–development program integrated across all involved organizations, including EM–30, EM–40, and EM–50, and Energy Research.

Conclusion: A relatively simple scenario–based approach to identifying and prioritizing technology–development needs is an effective and desirable method to focus technology–development efforts.

Recommendation: DOE should develop and rank tank–remediation scenarios leading to a prioritized list of technology needs as described above in those cases where it is not already doing so. The scenarios should be structured to define only the major steps from characterization through disposal or storage and to highlight only the major choices to be made. It is important that the scenarios not be presented in so much detail as to obscure the basic steps and issues.

Conclusion: There are a number of important technology needs related to managing high–level waste in tanks that are common to the four DOE sites that have alkaline nitrate supernatant–saltcake–sludge wastes. For the most part, the needs of the Idaho site are expected to be significantly different because the waste will be acidified. This indicates the need to integrate technology–development efforts through mechanisms such as focus area and cross–cutting programs, although the subcommittee has not yet had the opportunity to evaluate the effectiveness of the existing focus area.

Recommendation: An integrated technology–development program such as a focus area continues to be desirable to cost effectively develop technologies and share the results to the extent they are mutually applicable.

Conclusion: An effective technology–development program requires definition of key boundary conditions and the ability to establish how much technology development is required. A number of concerns in this regard have been identified that must be addressed to develop the technology necessary to manage high–level waste in tanks. These issues appear not to have been adressed definitively, and acceptable interim approaches have not been specified.

Recommendation: The DOE should explicitly address these concerns. Ideally, this would take the form of firm answers. More realistically, a well–conceived and consistent interim approach (e.g., use of prudently conservative waste–acceptance criteria, development of contingency technologies) should be explicitly defined.

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SUBCOMMITTEE ON MIXED WASTES

Scope and Tasks of the Subcommittee

The Committee on Environmental Management Technologies (CEMT) Subcommittee on Mixed Wastes was formed in 1995 to review the technological work of DOE, industry, and research institutions on mixed–waste management, identify the greatest needs in this focus area, and make annual recommendations to the CEMT. The subcommittee also addresses cross–cutting areas of relevance to the focus area such as robotics, efficient separation processes, and sensor technology and monitoring.

It appears that many, if not most, radioactive wastes simultaneously contain radioactive contaminants and chemically hazardous or potentially chemitoxic substances. Both groups of components are subject to restrictions to protect population as well as the environment, although rationales or bases for criteria are not necessarily identical.

For the purposes of this report, mixed wastes are defined as wastes contaminated with either transuranic elements (TRU) or low–level radioactive materials (MLLW). Sources of such waste are past and current nuclear activities (with a present inventory of at least 180,000 cubic meters) and also decontamination, cleaning, and restoration activities, such as remediation of plumes. Such wastes have to be extracted and/or collected, temporarily stored, treated, and finally disposed. The latter steps also imply general or specific characterization. The following topics will be considered in this report:

- availability of technologies in the frame of site treatment plans;
- needs for improved or new technologies;
- other drivers, such as efficiency, cost, quality of end product(s);
- impact of stakeholders.

The subcommittee will evaluate current or near–commercial technologies used or being proposed for the management of "mixed radioactive wastes"; evaluate the most promising technologies for mixed waste; consider development and implementation of technologies in the perspective of quantities, categories, location of wastes, and final disposal; suggest priorities for the development program; consider technologies in the perspective of regulatory requirements; and, where appropriate, consider non–U.S. technologies for management of mixed wastes.

Overview of the DOE Mixed–Waste Focus Area

The original strategic plans of the Mixed–Waste Focus Area (MWFA) are outlined in the *Predecisional Draft Strategic Plan for Technology Development* (USDOE, 1994). The stated mission of the MWFA is "to develop, demonstrate, and deliver technologies and treatment systems to treat and dispose of MLLW and MTRU in a safe, timely, and cost–effective manner" and to "be responsive to customer needs, . . . achieve compliance with regulatory requirements, and . . . achieve public acceptability." Additionally, the MWFA intends to have at least three pilot–scale demonstration systems treating actual mixed waste within three years. According to MWFA, these systems, if they are accepted for full–scale implementation, should be capable of treating 90 percent of the current MLLW inventory. The MWFA intends to accomplish its goals in seven years and then "go out of business." The more recent version of the *Program Management Plan* (USDOE, 1995) provides similar statements on mission and objectives.

One of the major considerations stated in this plan pertains to disposal of the treated mixed waste; however, no guidance or further plans for addressing this important consideration have been issued, which appears to be a serious omission in the DOE documentation. One of the most important process considerations related to disposal of mixed waste is the long–term performance of the waste form in the disposal facility.

Focusing on waste streams and needs for treatment technologies is a reasonable approach to defining and prioritizing the needs of technology development. The MWFA appears to be shifting toward this approach and should continue to do so. The focus area appears to be making progress identifying and prioritizing needs based on this waste–stream approach, and DOE's methods for prioritizing its needs for technology development based on this approach will be reviewed in the future by the Mixed–Waste Subcommittee.

The customers of the MWFA are identified as the DOE–EM Offices of Waste Management (EM–30), Environmental Restoration (EM–40), and Facility Transition (EM–60). The requirements for technology development of the DOE EM–30 are by far the most clearly defined of the three customers. Additionally, the planning documents appear to be focused toward supporting site treatment plans

(STPs), required by the Federal Facilities Compliance Act (FCCA), which is largely the responsibility of EM–30 and, to a degree, EM–40. This emphasis appears to be the correct initial emphasis for the MWFA, but the planning documents and subsequent work may benefit from more clearly defined customer needs. Such documents exist for the major nuclear DOE sites, but the degree of detail and specificity is far from uniform; the latter may illustrate the fact that conclusions cannot yet be drawn concerning technologies to be used and the evaluation of the actual problems.

The integration of DOE–EM's programs by means of focus areas involving DOE–EM headquarters, field offices, national laboratories, and other contractors is considered worthwhile by the subcommittee. A number of issues are confronting an integrated technology–development profile, such as deadlines established in legally binding negotiations, the balance between near–term and future technology–development needs, the activities being funded, issues involved in the process required by the FFCA, and strategies to decide where treatment facilities would be located to handle each category of waste stream in consonance with site consent orders. Information from EM–30 and EM–40 on how their needs are being addressed would be worthwhile to the subcommittee.

Increasing public acceptance of the technologies to be developed is a worthy goal of the MWFA and the plans under development to enhance this effort should continue.

Regulatory Aspects

Mixed waste presents unique regulatory issues because of separate and sometimes inconsistent regulations that deal with hazardous waste and radioactive components. Four primary laws that relate to management of radioactive constituents are monitored by the USNRC, the Agreement States, and DOE. However, eleven primary laws that regulate the hazardous constituents of mixed waste are implemented and controlled by a number of agencies such as the U.S. Environmental Protection Agency (EPA), state and local waste–management agencies, state or local air–quality districts, local water and sanitation districts, and federal and state offices of the Office of Safety and Health Administration (OSHA).

The Federal Facility Compliance Act (FFCA) of 1992 sets out a framework for mixed–waste management by DOE that directly affects the program and priorities of the Mixed–Waste Focus Area. The FFCA amended the Resource Conservation and Recovery Act (RCRA) and defines mixed waste broadly as waste that contains both hazardous waste and sources, special nuclear, or by–product material subject to the Atomic Energy Act of 1954. The FFCA required DOE to prepare a report containing a national inventory of mixed waste on a state–by–state basis and a report containing a national inventory of mixed–waste treatment capacities and technologies.

These reports were published by DOE in 1993 and helped set the framework for technology development for mixed–waste management. In addition to these two reports, the FFCA required DOE to devise mixed–waste plans for development of treatment capacities and technologies. These mixed–waste plans were required for each DOE facility that does not already have a state agreement. Although short planning horizons under these regulations have created a near–term impetus for selection of conventional treatment technologies, such as incineration, physical/chemical treatment, and basic separation technology, the site plans appear to provide for flexibility and do not restrict severely the application of technology that is in the development stage at this time. The status of the plan should be considered if new R&D begins on waste streams that are on schedule for treatment.

The mixed–waste plans and the inventory of technologies are intended to comply with the treatment standards of the land–disposal restrictions of RCRA. EPA has promulgated treatment standards for each of the EPA hazardous waste codes, which also identify mixed waste. The standards generally define maximum levels of hazardous constituents in the treatment residue to be landfilled based on Best Demonstrated Available Technology.

EPA is promulgating two new regulations that will have a large influence on the treatment and definition of mixed waste. First, the Hazardous Waste Identification Rule (HWIR) will attempt to define waste on a national basis by threshold concentrations of listed hazardous waste. This regulation, which may become effective in 1996, could remove significant quantities of DOE mixed waste from the RCRA regulatory scheme. Second, the EPA Combustion Strategy, also scheduled for promulgation in 1996, will affect greatly the permit requirements for thermal treatment processes such as incineration, plasma hearths and arcs, and vitrification. Technologies operating at lower temperatures could be easier to permit because they fall outside the incinerator requirements. However, these technologies may require permits under RCRA Subpart X, although most of them have not yet reached a sufficient state of development and demonstration.

In addition, the plans for DOE facilities must be approved by states with authority to prohibit land disposal of mixed waste or the EPA administrator after public participation. The involvement of the public and local regulators complicates a difficult permitting process for treatment facilities.

This permit process and public involvement are critical aspects of any environmental technology–development program. For example, the efforts of the EPA National Technical Workgroup seem to be a constructive approach. DOE should increase activities that will assist in the streamlining of the permit process. Such efforts should allow the public and regulators information, understanding, and assurance that alternative technologies have been addressed adequately. Such information would demonstrate that the most appropriate waste–treatment technology has been selected and that rigorous scientific criteria for technical effectiveness, health and safety to people and the environment, reliability, and cost are addressed during the permitting process.

Criteria for Technology Development

Two basic criteria for technology development have been identified by the MWFA in its 1994 Management Plan: (1) improve performance, reduce risks, and minimize life–cycle costs over existing technology; and (2) develop treatment capability for waste streams that cannot be treated with existing technology. These criteria appear to be appropriate for technology development for mixed–waste treatment; however, it should be noted that each of these criteria cannot be optimized individually and that tradeoffs will be required. Additionally, choosing the proper balance among these tradeoffs will necessitate both value and technical judgments. For example, reducing risks and minimizing life–cycle costs are sometimes conflicting criteria.

Technical criteria can be established to achieve the basic criteria mentioned above. For example, by identifying the waste streams for which treatment technologies currently exist and are satisfactory, the technology–development needs can be focused on the remaining waste streams. The obvious place to start is the FFCA site–treatment plans. Some of these waste streams may be amenable to treatment by existing technology with only minor modification, while other waste streams may require more important adaptation or even new technology. A systems approach that evaluates a treatment technology with respect to volume reduction, regulatory requirements, characterization efforts, and final waste–form performance should be used to identify these technology needs.

At the first level, DOE should know if technology development is to replace existing technology or if it is for a waste stream that currently has no associated treatment technology. The former assumes that a technology currently exists but has some unacceptable attributes, such as high cost, low efficiency, a narrow envelope for waste inputs, or excessive secondary waste streams. The attributes of the developing technology must clearly be better than the existing technology to warrant continued development. A careful analysis of the existing technology may shed light on opportunities for developing technology.

Because a large fraction of waste–treatment cost is for characterization, treatment technologies that can accept a wide range of waste requiring only limited waste–characterization may be more desirable than technologies requiring more detailed characterization. Of course, some minimum degree of characterization will always be required, and this baseline level could be used to benchmark the additional characterization required for potential treatment technologies under consideration.

The final waste form is another important consideration for evaluating technology development (e.g., because the radionuclide concentrations resulting from the volume reduction caused by some treatment processes may preclude disposal in a near–surface facility by failing certain waste acceptance criteria or by requiring a secondary stabilization treatment). Also, the long–term performance of the waste form in a disposal facility must be assessed, and short–term test procedures must be developed to provide indication of the waste form long–term performance. Other end points to development of individual technologies include the documentation requirements for safety and performance assessments for new technology systems. The determination that a sufficient number of treatment technologies is available to meet the DOE's mixed–waste treatment needs could serve as the end point of the program as a whole or of specific developments.

Significant progress toward focusing and prioritizing technology development along these lines has been made. However, the MWFA should also incorporate a broader systems approach in its ongoing efforts and consider factors such as volume reduction, toxicity, risk to the environment and the operators, characteristics of the end product, cost for development and operation. This broader approach will help to ensure that all important factors are considered in the selection of developing technology.

Status of Current Technologies

Waste Types and Assessment/Characterization

Waste composition dictates the range of technologies that can be applied to achieve the desired technical, regulatory, and social objectives. The MWFA encompasses over 100 waste types in five general classes: combustible organics; soils, debris, and solids; sludges; wastewater slurries and inorganics; and special wastes.

DOE has several projects designed to inspect drums for leaks and for shipment suitability, measurements of volumes, density, and radioactivity determination that will be demonstrated in the field in the next two years. The usefulness of these techniques for controlling a waste feed to a treatment technology is uncertain and must be related to the treatment technique's sensitivity to variation in feed composition and other specific factors, such as potential criticality and direct chemical hazards.

Similarly, analytical control for treatment processes, emissions monitoring, and disposal suitability of the end products are highly specific and must be addressed as part of the treatment technology. The chosen technique preferably should be automated, rugged, and reliable, and should provide as close to possible real–time analysis. An example of these needs is the flow–through alpha monitor, which detects low concentrations of alpha emitters in gas streams. This method is to be field tested in 1996.

All proposed mixed–waste treatment processes emit gaseous effluents. Emissions of volatile metals; radioactive particles; and compounds such as chlorinated dioxins and furans, products of incomplete combustion or thermal cracking under pyrolysis conditions, are a major public concern and health risk. Work in the real–time analysis of these pollutants should be emphasized because it can be applicable to almost all waste–treatment processes.

Technology Development and Selection

Historically, waste–disposal and waste–treatment practices have focused initially on methods that can treat or dispose of a large variety of wastes, such as landfills and incinerators. As special procedures became available for specific wastes, combinations of treatment began to be applied to many waste streams.

At this stage, DOE has examined a number of treatment technologies that are very broad in scope. Plasma technology, vitrification, encapsulation, and others were chosen for their expected broad range of applicability to wide ranges of wastes. These technologies will be evaluated carefully but, according to present information, these technologies look promising and mature. Other technologies, such as supercritical water oxidation (SCWO), electrochemical oxidation (EO), and some others, also initially were intended to treat a wide range of wastes, but they are still developmental, and it appears that they may only be used for selected waste streams. As these technologies become more mature, they can be evaluated in a systems approach that defines waste–characterization issues, pre–treatment requirements, treatment, waste streams and waste form, and regulatory/social issues. This systems approach is being applied by DOE in its recent evaluation of thermal–treatment processes and the current study of nonthermal processes.

Thinking of technology as a system designed for treatment of specific types of wastes should be DOE's future approach. Identifying waste composition and treatment systems has begun and appears to be a major effort by DOE that should continue.

Thermal Treatment

DOE has carried out a comprehensive examination of a range of thermal–treatment options in comparison to the existing commercial, slagging rotary kiln incinerator. In view of the risk remaining in developing technologies versus the long–term experience with the incinerators, it is not clear that economic advantages will be gained from applying these new, developing technologies.

However, potential technical and social advantages may be gained from applying technology other than incineration. Plasma–technology investigators claim that the process could treat a wide range of organic and radioactive components with lower gaseous effluents than in the case of incineration. Nevertheless, considerable gas emissions may still occur (possibly with high concentrations of impurities) which would require rigorous control. In principle, the slag residue is a good waste form against ground–water leakage under repository conditions. DOE announced it will be field testing a unit on radioactive waste within two years. Long–term reliability and duty requirements have to be verified before this process can be considered suitable for commercial use in the future (about the year 2000).

Among the group of technologies based on the use of a molten metal bath for waste treatment or the recovery of metals, is Quantum–CEP™, a trademark of M4 Environmental L.P. The technology is close to commercialization, and a field demonstration using radioactive waste is proposed. The field demonstration experience should also contribute to the evaluation of the application of the technology (e.g., nature of feed materials and end products) and, possibly, needs for further development.

Vitrification treats waste streams contaminated with radionuclides, metals, and organics. It has been field tested and is essentially commercial for liquid high–level wastes. Gas emissions must be controlled during the vitrification process, as in other treatments.

Nonthermal Processes

DOE is carrying out a systems evaluation for the following technologies: catalytic oxidation for organics in water, electrochemical oxidation of organics, electron–beam destruction of organics in water or gas, photo–oxidation of organics in water, high–energy corona discharge for organics in gas streams, and many others. These technologies have been chosen from an initial list of over 200 commonly used technologies. The selected technologies are in the bench phase of development and would appear to be at least eight years from potential commercial operation. It may be possible that these technologies will find an earlier application for specific waste streams that are suited for the attributes of the technology.

A broad range of separation technologies can be applied for pre– or post–treatment of waste. Soil washing and thermal desorption are examples of commercial technologies. In the area of soil washing, increasing the efficiency of removal of pollutants from soil remains a critical issue. Indirectly heated thermal desorption is a commercial technology for removing organic pollutants and mercury from solids. This technology offers organic separation and gas effluent streams that are 2–10 percent of the air emission of incinerators. Indirect thermal desorption should be examined further in any system evaluation for wastes containing organic constituents. Demonstrations with radioactive components are being planned.

Stabilization and Containment

Vitrification can be used to stabilize a range of inorganic and metal wastes. The technology can be applied at different temperatures,. using varying process configurations, and using different additives for the glass–making process. The technology is commercial except that more field testing on low–level radioactive wastes will be performed within the next two years.

Polyethylene encapsulation is suitable for many wastes such as debris and residuals and for streams that are not amenable to vitrification. The technology has been field tested and is close to commercialization. Stability of waste and encapsulation metrix may remain a concern in certain cases.

Phosphate–bonded ceramic waste stabilization will be field tested within the next two years on residues from the plasma process.

Summary

DOE is demonstrating a number of technologies that can be applied to the very large range of mixed wastes. This variety of technologies can contribute to the treatment of diverse waste; nevertheless, developing many variants of the same basic technology does not seem to be justified.

At this stage of the development cycle, it seems more important to focus heavily on the waste streams and to examine alternative systems likely to treat the wastes of interest than to demonstrate technology. By combining a range of waste analysis methods, pre– and post–treatment separation and treatment methods, developed technologies, and analyses of the acceptability of the waste product, waste–stream groupings can be identified for which no good solution currently exists and which are therefore candidates for research. DOE has such a program planned for the coming year.

Some problems may require new methods or subprocesses or new approaches. Such problems may, for example, be related to specific volatile metallic components. For these, it is important that priorities be established both for the waste to be treated and for technologies to be developed. More attention should be paid to the evaluation of the related problems and their relative priority.

Much effort is being spent by DOE on developing nonthermal methods for the destruction of organic components in mixed waste. One incentive has been to avoid high temperatures which may generate problems related to off gases and off–gas purification. A first impression is that these nonthermal processes are still less developed than thermal processes; nevertheless, they deserve proper attention, for example, for well–specified homogeneous waste.

Potential future use of developmental thermal technologies should be evaluated in terms of risks and technical and economic aspects versus proven technologies. Most importantly, strong public involvement must be maintained to overcome potential hurdles that new technologies will face as their technical problems become more apparent with longer use.

Most treatment facilities have gas emissions. Gas–emission control and real–time monitoring of pollutants of concern are an important area of research that should be continued.

Issues Affecting Technology Development and Use

Impact of Public Involvement/Concern

Prior to 1984, the management of hazardous and mixed waste at DOE facilities was shielded from public review. After agreeing to comply with RCRA and other federal and state environmental laws at its facilities, the DOE initiated a policy of public openness. DOE established advisory committees of stakeholders to interface with facility operators on environmental issues. Similar to the increased public participation resulting from the 1984 Hazardous and Solid Waste Act Amendments and the 1996 Superfund Amendments and Reauthorization Act, the 1992 FFCA further increased public participation in DOE affairs. Also, the states made the facility site plans available to the public.

These actions resulted in the public voicing concerns about conventional incineration and the transport of mixed wastes off–site for disposal. While these concerns are often emotional, it would be inappropriate to label them as only "nontechnical" because they are rooted in the nature of the technology and a risk of vehicular accident during transport, respectively.

DOE has shown responsiveness to these concerns in its mixed–waste technology development strategy and in its mixed–waste treatment plans by focusing on alternatives to conventional incineration and by attempting to plan for the treatment of most wastes at the site where they are currently stored. In addition, DOE has selected continuous monitoring for incinerators as a means of addressing stakeholder concerns regarding toxic emissions as a priority.

Political Issues

Political issues continue to play a role in DOE waste–management technology decisions. Political pressures within states for rapid reform of DOE waste–management programs may have resulted in technology choices in previous state agreements that are in need of review. Furthermore, the large amounts of money required for cleanup and waste management at DOE facilities and the finite DOE budget could create political competition among host states for large projects that may or may not be part of the DOE mixed–waste strategies. Finally, the ultimate political issue becomes the viability of DOE's technology–development plans in the face of major budget cuts proposed by Congress. Constraints on the DOE–EM budget likely will continue for the next several years, placing an emphasis on low cost or highly effective treatment technology and shorter–term returns. DOE should develop a prioritization plan that presents a clear basis for funding technology development during times of severe budget constraints.

Regulatory Reform

The proposed Hazardous Waste Identification Rule (HWIR) planned to be published for public comment in the coming months may have an important impact on the need for treatment capacity for mixed wastes and associated technological development. Because the HWIR is expected to propose concentration thresholds for RCRA listed wastes below which these wastes are no longer considered hazardous, this rulemaking may cause large quantities of mixed waste to be reclassified as strictly radioactive waste and may negate the need for some treatment. The MWFA should closely monitor this rulemaking to understand the impact it may have on DOE's technology development.

Cost/Benefit

The MWFA has determined that 90 percent of the mixed–waste streams can be treated with technologies that currently exist or that can be modified. Therefore, the majority of technology development will likely be focused toward improving these present technologies. Standard measures for evaluating and comparing alternatives should be used, including cost–benefit analysis. Because the MWFA is interested in reducing the overall life–cycle costs, the cost–benefit analysis should entail a broad view of the complete system, including waste–characterization efforts and final waste form for disposal. Decision metrics should be clearly articulated, and flexibility should be built into the decision process to revise the metrics if better metrics are found.

However, decisions pertaining to selection of innovative technologies based solely on cost–benefit analysis should be avoided. In particular, funding basic research with the potential to deliver technologies having large but undefined financial payoffs in the future should be supported. The benefits of basic research are often hard to quantify, and holding this research to strict equations of cost and benefit may cause DOE to forego some promising research.

Privatization

Many of the site treatment plans (STP) specify treatment of a large percentage of waste streams in private treatment facilities. The basis for this trend is unclear. The issue of privatization was discussed by the subcommittee with no resolution. Some issues requiring resolution include (1) the degree of latitude to the bidders in specifying and designing technology systems and (2) the proper level within the system at which to privatize (i.e., individual components, treatment units, or entire treatment trains).

Conclusions and Recommendations

Conclusion: Among the criteria for the selection of treatment technologies, the physical and chemical characteristics and volume of the end products—or the need for secondary immobilization—are integral and important issues in waste management. These criteria also mean that the option for a type of disposal environment (not necessarily the disposal site) and current or expected regulatory restrictions related to disposal are of great significance.

Recommendation: DOE–EM should give full consideration to the characteristics of the final waste form from the perspective of its potential disposal environment.

Conclusion: Selection of treatment technology and decisions for development of new technologies should be based primarily on perceived needs associated with specific waste streams. For "near–mature" technologies, the potential advantages and types of wastes treated need further evaluation. Application of available and near–mature technologies may still leave some waste–treatment problems unsolved and, for the latter, new approaches may be required.

Recommendation: DOE should establish R&D priorities on the basis of quantities of wastes, associated risks, available technologies, and regulatory constraints. Ultimately, treatment technologies must be evaluated as a total system, including disposal, and in life–cycle context.

Conclusion: For several categories of wastes, mainly those containing organic components, nonthermal destruction processes may look attractive when compared with established thermal technologies. However, the majority of the nonthermal processes are still in an early stage of development and/or demonstration.

Recommendation: In the comparison of thermal and nonthermal treatment methods and establishment of relative priorities, the stage of development, end–product characteristics, technical and economic advantages, and potential for improvements of thermal processes should be considered.

Conclusion: Adequate characterization, adapted to the requirements of specific treatment technologies and the properties of handled materials, is a critical element for successful and cost–effective implementation of mixed–waste management.

Recommendation: Characterization techniques should be adapted and limited to meet the essential requirements of the treatment processes and waste–management systems.

Conclusion: The permit process and public involvement are critical aspects of any environmental technology–development program.

Recommendation: DOE should increase activities that assist in streamlining the permit process and stakeholder involvement.

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SUBCOMMITTEE ON DECONTAMINATION AND DECOMMISSIONING

Introduction

The end of the Cold War and the downsizing of the nuclear weapons complex present a major change in emphasis and magnitude of the tasks facing the U.S. Department of Energy (DOE). DOE nuclear facilities no longer in use are being deactivated and need to be decontaminated, and DOE believes many must be decommissioned. As stated in *Estimating the Cold War Mortgage: The Baseline Environmental Management Report (BEMR)* (USDOE, 1995a), DOE estimates the scope of the current problem includes approximately 7000 contaminated buildings, of which 700 are candidates for decommissioning. Contained in these structures are, reportedly, over 500,000 metric tons of contaminated metal and mixed units over a billion cubic feet of contaminated concrete. DOE–EM's technology–development program is aimed at developing and implementing technologies that will address these problems safely and cost effectively.

The Decontamination and Decommissioning (D&D) Subcommittee was established to assist the Committee on Environmental Management Technologies (CEMT) in assessing/evaluating technological needs in DOE's D&D Focus Area.

Planning Documents

The DOE provided the subcommittee with three principal draft planning documents to convey the foundation of the focus area's efforts and planned approach to date. These documents were *DOE's Strategic Plan* (USDOE, 1995c), *Management Plan* (USDOE, 1995e), and *Implementation Plan* (USDOE, 1995d). DOE D&D and general resources were also transmitted to the subcommittee at various times *D&D Focus Area Technology Summary* (USDOE, 1995), and *Decommissioning Handbook*

(USDOE, 1994). DOE advised that the three major planning documents are being reviewed within the department and may be issued in final form before the end of 1995. Although the three planning documents will change from time to time to reflect the evolving nature of DOE priorities, the following elements seemed to be lacking:

- a systematic needs assessment;
- a systematic assessment of available technologies including disposal options;
- a matching of available technologies with the needs;
- an identification of technology gaps;
- development of criteria within appropriate constraints (e.g., acceptable risk, regulatory drivers, stakeholder agreements, cost–benefit analyses) to enable priorities to be established; and
- guidelines for development and implementation of a comprehensive, integrated program involving a suite of projects from basic and applied research through large–scale demonstration and implementation depending on the maturity level of the technology.

As a foundation for the selection, evaluation, and prioritization of candidate D&D technologies, a clearly defined set of criteria for D&D technology application and performance is a necessary first step for the D&D Focus Area. Among the more important attributes of the performance criteria are

- technical feasibility,
- compliance with regulatory constraints,
- worker and public health and safety,
- economic viability,
- political/stakeholder acceptability, and
- end–user satisfaction in addressing specific tasks.

The eventual use of DOE sites will determine the end points of the D&D remediation efforts. Establishing quantification criteria for the necessary and sufficient cleanup of DOE sites is certainly a primary factor driving D&D technology development. Whether DOE can develop a system of criteria to yield specific site–cleanup objectives remains to be determined, but DOE should attempt to do so. Remediation of certain sections of DOE sites to pristine levels may well be prohibitively expensive and unnecessary. Many argue that certain sections of DOE sites should be left as "brown fields," suitable for certain kinds of industrial development.

DOE seeks to minimize the financial requirements of its D&D programs by promoting the possible resale of recovered metals, the commercialization of technologies that it might develop, and various privatization efforts. Further comment may be made on these matters as additional information is received and analyzed, but the fact that DOE appears to be relying on a domestic and foreign market potential for yet–to–be developed technologies in the absence of any documented assessment of the status of these D&D technologies and needs raises concern.

Conclusions and Recommendations

Conclusion: DOE EM–50 has stated to the subcommittee that new technologies are needed to perform D&D tasks safer, better, cheaper, and faster than is possible with presently available technologies. However, no documentation of the basis for this premise, which is the justification for the entire technology–development program, has been provided or identified. At the same meeting, the subcommittee heard from EM–40 at headquarters that all necessary technology is in hand.

Recommendation: Using external peer review as appropriate, DOE should establish criteria by which to compare and evaluate the effectiveness of existing and candidate technologies and a means by which deficiencies can be evaluated. The basis for projecting the needs for and or the superiority of future technologies then should be stated explicitly. The process should start with a needs assessment for the D&D Focus Area and should identify available technologies, technology gaps, and criteria for establishing priorities.

Conclusion: The D&D Focus Area Strategic Plan, with its emphasis on relatively mature technologies and large–scale demonstrations, is too narrowly focused.

Recommendation: The D&D Focus Area should revise its strategic plan to provide a basis for a comprehensive D&D technology–development program. This plan should specify a process that will yield a systematic assessment of D&D needs and available technologies, the identification of technology gaps, the development of criteria for establishing priorities, and a justification for demonstration projects that will be funded and executed. The product of this effort should be a balanced program of basic and applied research, exploratory and advanced development, engineering design, demonstration, and implementation.

Conclusion: A strategic plan is best if flexible. Indeed, strategic planners (see e.g., Andrews, 1987; Goold and Quinn 1990; Mintzberg, 1978, 1979, 1981; Mintzberg et al., 1976; Quinn, 1977, 1980) have demonstrated that many of the best strategies emerge without the benefit of a rigid planning document. Although flexibility is very difficult to achieve in the public sector, DOE does not need another formal or rigid plan to follow. It is not evident that any progress on finalizing the draft plans has been made since CEMT's report for 1994 (NRC, 1995), and the goal of producing a "final" plan this year may be unrealistic.

Recommendation: The D&D strategic plan should be a living document. If the planning documents are "finalized" by the end of this year, DOE should include provision for future periodic revisions.

Conclusion: DOE should address planning in terms of a *process* and should not have to contract for the drafting of the strategic planning document. In order for the plans to succeed, DOE decision makers themselves (and not their support contractors) should draft the plans. Many organizations have found that the most valuable aspect of any strategic planning exercise is the *process* of assembling the plan rather than the specific details of the plan.

Recommendation: DOE should set aside time for the planning exercise. The plan will succeed best if it has commitment from the highest and broadest levels of management, so it must include the undivided attention of the highest-level decision makers. If three planning documents are developed, different levels of DOE representatives could draft the different plans, but the strategic planning document must include the highest-level decision makers. The Management Plan should include those responsible for managing the plan. The Implementation Plan should include those individuals who will implement the plan.

Conclusion: The drafts of the Strategic, Management, and Implementation plans are inconsistent in language, definitions, process structure, and criteria and fail to provide a usable roadmap from which detailed scheduling and milestones can be developed within annually approved budgets.

Recommendation: DOE should establish an action plan that leads to the early revision and issuance of each of the three plans. The plans should incorporate specific language, definitions, process structures, and performance criteria that are consistent across the three principal planning documents. Areas of emphasis should include priorities, discussion and integration of performance criteria, assessment of the scope of work vis–a–vis the other focus areas, and related technology development for D&D within DOE.

Conclusion: The D&D Focus Area Management and Implementation plans fail to include adequate recognition of and coordination with appropriate activities underway in other parts of DOE and with independent technology development in the private sector and abroad.

Recommendation: The revisions of the Management and Implementation plans should include an evaluation of private sector and non–U.S. technology developments.

Conclusion: DOE apparently expects benefits will accrue to it by commercialization of newly developed D&D technologies. No indication of source or market potential to support this expectation could be found.

Recommendation: Without a basis for potential commercialization, DOE should not permit consideration of commercial potential to affect the selection, development, or utilization of new technologies.

Conclusion: No basis for establishing levels of site cleanup to be achieved, other than the need to comply with statutory, regulatory, and contractual requirements is evident. End–use risk and cost are also major drivers.

Recommendation: DOE is in urgent need of defining criteria by which the level of site cleanup on a "necessary and sufficient" basis within regulatory constraints can be determined. Such an exercise might indicate current technologies to be entirely adequate to meet cost and schedule targets.

Conclusion: DOE does not have a fully integrated "D&D Technology Needs Evaluation Document" that justifies the large–scale demonstration projects that DOE is scheduled to fund. Four D&D large–scale demonstrations that will showcase specific D&D operations are scheduled for the next two years; however, it is not clear how these demonstrations will be evaluated and documented to capitalize on their successes and failures in future D&D activities.

Recommendation: A cost–benefit study is needed for the three or four most critical D&D technologies expected to reduce the cost of decommissioning significantly without compromising safety. The study should evaluate the status of current technologies nationally and internationally, using external peer review as appropriate, and assess how many dollars can be saved throughout the DOE Complex for each research and development dollar spent to develop new technology or improve existing technology. Current technology–development programs that do not have a return on investment for the development dollars being spent should be terminated. For the scheduled large–scale demonstrations, specific evaluation and analysis procedures should be developed before further funding is committed.

Conclusion: Systemic DOE–wide issues, such as the lack of an "end–use" standard or policy, the ongoing debate between a "national" versus a more region–based management strategy, or the impacts from highly prescriptive regulations or DOE orders, place significant burdens on the successful achievement of technology development by the D&D Focus Area. While such systemic problems are beyond the immediate control of the focus area, the draft documents offer little recognition of these significant concerns and do not propose alternative strategies to compensate for these issues in the development of D&D technologies.

Recommendation: The D&D Focus Area should address these significant larger issues in its planning process, supporting documentation, and structured interaction with DOE, other agencies, its industrial partners, and stakeholders. The draft documents should be re–assessed to highlight areas affected by these systemic problems and to include decision points that address specific issues affecting planned technology development.

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CROSS–CUTTING AREAS AND TECHNOLOGIES OF IMPORTANCE

There are several waste–management or site–remediation technologies central to the DOE waste–management technology–development program that will be used across the five focus areas. Some are formally designated as cross–cutting areas, and their development is being managed under that heading. Others, even though they have generic application, are being managed separately within the five focus areas. Often, the development of technologies in the latter categories is further segmented on a site–specific basis. While site–specific development may be justified on the basis that the wastes and remediation targets vary from one location to another, it often leads to duplication of effort or to gaps in technology development. This problem of uncoordinated R&D activity on topics of generic interest across the focus areas and sites is addressed in the main body of this report.

In some of the five focus–area working papers in Appendix A, the waste–management activities have been classified in the sequence:

- characterization,
- retrieval,
- treatment,
- stabilization, and
- disposal.

This sequence, which seems to apply fairly well to the tank waste, mixed waste, and landfill areas, can be used as a framework to treat the CEMT evaluation and discussion of EM–50 activities.

- Characterization embraces the areas of *site characterization* and *waste characterization.* It also relies heavily on developments in *monitoring and sensor technology*, a technological area that is critical to all five of the waste–management activities and all five focus areas.
- Retrieval is often site and waste specific, but it seems likely that *robotics* will play a critical role in retrieval of certain stored or buried wastes. As noted in the individual working papers, *robotics* is also widely applicable in the characterization, treatment, stabilization, and disposal of toxic and radioactive waste materials.
- Treatment is also a waste–specific activity that can employ a variety of generic technologies. *Separations* is critical to reducing the volume of high–level radioactive waste and to reducing the cost and risk of disposal. For wastes containing high concentrations of organic materials, *incineration* or *supercritical water oxidation* can be very effective in reducing the chemical toxicity and volume of wastes, especially when conducted with up–to–date process technology. The treatment technologies may also embrace homogenization of wastes, especially when the stored materials are as varied and heterogeneous as those in the Hanford, Washington, tanks. *Robotics* have obvious applications in the manipulations involved in homogenizing such dangerous substances. *Monitoring* process streams and emissions will be a critical activity.
- Stabilization of treated wastes prepares them for interim or permanent disposal. It appears that *vitrification* is likely to be the technology for stabilization of high–level radioactive materials at the major tank waste sites. *Vitrification*, grout production, or encapsulation may be options for low–level wastes.
- *Disposal* of solid, stabilized wastes may take place in conventional landfills or in highly secure, radioactive waste repositories. Whatever the disposal mode, *monitoring* of the disposal site may be needed for long periods of time. As noted in the landfill stabilization focus area discussion, this topic of long–term landfill *monitoring* seems to have received less attention than it merits.

The cross–cutting technologies highlighted in italics above are discussed in more detail below.

Site Characterization

Site characterization is critical to understanding subsurface conditions and processes and thus to determining the appropriate course of action for remediation at a particular site. Thorough site characterization, along with technical practicability issues and future land–use scenarios, will enable DOE to select appropriate remedial measures to manage the site. These remedial measures could include one or more of the following:

- source treatment, containment or removal, where practicable;
- ground–water pump and treat for dissolved portions of the plumes;
- in–situ treatment;
- hydraulic containment;
- institutional controls; and
- basinwide ground–water resource management.

To justify the selection of any of these alternatives, the scientific basis of the data used as input to the risk–assessment process or the justification for technical impracticability must be sound. Thus, the extent, quality, and type of site characterization are critical. Too often, too much of the wrong data have been collected at sites across the country (not just DOE sites). The need exists for a comprehensive program that incorporates site characterization as a means to an end, rather than an end in itself. DOE seems to have embraced this philosophy in its cross–cutting efforts for site characterization (e.g., the SEAMIST™[13] and related work that has been performed at the Savannah River Site).

Before selecting appropriate actions at a site, some of the aspects listed below must be understood:

- the nature and distribution in space of the subsurface materials, whether the soils are fine or course grained, heterogeneity of subsurface materials, or whether fractured bedrock exists;
- the hydraulic characteristics of the subsurface and the corresponding behavior of the contaminants in question;
- the mineralogical composition and organic matter content of the rock; and
- the type of contaminants present; whether they are metals, radionuclides, dissolved constituents, separate–phase organic liquids (light nonaqueous phase liquids (LNAPLs) or dense phase liquids (DNAPLs)), and their wettability.

Most of these aspects of site characterization can be fairly straightforward (albeit time consuming and expensive); however, the technology to detect the presence of DNAPL does not exist. Currently, the industry uses "indicators" to assess whether DNAPL is present (e.g., whether DNAPL compounds are present at a percentage of its aqueous or vapor solubility, and whether historic practices indicate that separate phase liquids could have been released).

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[13] SEAMIST™ (patented trademark of Eastman Cherrington Environmental) is a concept of drill–hole instrumentation and fluid sample collection using a membrane insertion technique.

DOE is actively engaged in efforts to improve DNAPL characterization. Because this problem is not unique to DOE and because several other DNAPL characterization efforts are underway both nationally and internationally, DOE should either de–emphasize this effort internally or work collaboratively with other institutions. DOE should strive to reduce its duplication of efforts in this area.

In–field monitoring, imaging, and sensor technology are the best ways to minimize the costs and time associated with detailed site–characterization programs. DOE should concentrate its efforts in this arena, especially if it will attempt to reduce the cost of characterizing plumes and landfills by half in fiscal year 1997, a goal that appears overly optimistic.

DOE is particularly well suited to continue its efforts in the development of monitoring, imaging, and sensor technology given the work at several of the national laboratories. For example, Lawrence Livermore National Laboratory's (LLNL) development and use of electrical resistance topography to track subsurface heat differentials should be expanded into other areas (perhaps the tracking of separate phase liquids). The continued development and refinement of cost–effective field detectors that can assess metals and radionuclides in soils should be encouraged. In addition, DOE's efforts in remote sensing and imaging technologies to elucidate subsurface physical and hydraulic conditions should be encouraged.

In summary, DOE should continue its efforts in the cross–cutting arena of site characterization. To minimize duplication of effort, it should endeavor to form collaborative coalitions both internally and externally. Finally, DOE should review its program periodically to ensure that its technology–development efforts match the needs of the end users in its ever–evolving environmental–management and restoration program.

Waste Characterization

A major element in the strategy for dealing with stored wastes is learning the scope and character of the problem at a given site. Major challenges are (1) characterization of the contents of large storage tanks at sites such as Hanford and Savannah River, and (2) identification of the contents of barrels, especially those buried at many sites across the United States. Some knowledge of the nature of the wastes is needed to design the facilities to prepare the waste materials for permanent disposal. The degree of characterization required will vary from site to site, depending on the extent to which the contents of different tanks and drum–storage areas will be combined and homogenized before treatment and the sensitivity of selected treatment technologies to homogeneity and composition of the feed.

Tank wastes are often inhomogeneous with both liquid and solid phases being found in any vertical cross section of a tank. Even worse, the contents may differ in character across a tank at a given depth. The inhomogeneities in the solid phases are determined conventionally by analyzing core samples taken at accessible points across the tank. This approach is slow, hazardous, and incomplete. Two techniques under development offer considerable improvement in speed and cost effectiveness. The cone penetrometer, which is coming into use, provides considerable physical information on the nature of the phases as well as the positions of the interphase boundaries. Attachment of chemical probes to the penetrometer can give added information about aspects such as pH and moisture content. Similarly, new spectroscopic tools are being developed to characterize the organic materials that are of concern. Another tool under development that should help deal with the lateral inhomogeneity problem is the Light Duty Utility Arm (LDUA), which can move a variety of probes to various positions across the surface of the tank contents.

Another aspect of tank–waste characterization R&D is development of new probes to measure a variety of waste characteristics. A particularly important property is moisture content, because it is believed that 20–30 percent water is needed to prevent explosions from reaction of organic components with the nitrates present in many of the tanks. A thermal neutron technique is in advanced development at Hanford, but an electromagnetic induction technique may permit measurement of moisture content at greater ranges (one foot or more). Several spectroscopic probes such as infrared and Raman spectroscopy are being adapted for use in tanks, both for analysis of the headspace gases and for characterization of species such as nitrate and ferrocyanide in the liquid phases.

The problems of characterizing the wastes stored in drums are as complex as those associated with tank wastes. About 1.5 million barrels of wastes (some radioactive, some hazardous chemicals, and many mixed) are stored at various sites. Apart from the safety aspect, the sheer number of drums makes it impractical to sample intrusively more than a small fraction for conventional chemical or radiological analyses. A major development effort is being applied to nonintrusive techniques, such as acoustic imaging, which can be used to identify the quantity, density, and phases of drum contents. This information, coupled with targeted sampling, can provide the basis for choice and design of treatment techniques to be applied at a site. If nonintrusive characterization can be extended to some assessment of the composition of drum contents, it will be a major contribution to the strategy for drum–storage remediation. For drums containing radioactive material, external multispectral emission radiation spectroscopy can also help identify the whole waste content or anomalous drums.

The development of technology for imaging and analytical characterization of wastes stored in tanks and drums seems to receive appropriately high priority in the EM–50 program. The technology development appears to be well focused toward possible applications in the remediation programs. It is not clear how well EM–50's work in this area is integrated with that of the potential implementers and whether new characterization techniques are being implemented as rapidly as possible.

Monitoring and Sensor Technology

The technologies for monitoring emissions, controlling processes, and performing in–situ analyses present large opportunities for savings of time and money in waste management and environmental restoration, not just for DOE, but also for other federal agencies and for private industry. Development of advanced sensors and monitoring techniques is important to all five focus areas and plays a critical role in the characterization of tank wastes, as noted in the "Waste Characterization" section above.

Monitors that analyze gas composition are needed to characterize the headspace in tanks; the air in work places and drum–storage areas; and emissions from incinerators, plasma hearths, and other waste–treatment facilities. Gas chromatography has been a standard tool for these analyses but is being enhanced continuously in both versatility and specificity by development of new types of detectors such as ion–trap mass spectrometry. Direct sampling mass spectrometry and long–path Fourier Transform Infrared (FTIR) spectroscopy are in advanced development and the early stages of implementation for vapor and gas analyses. DOE National Laboratories are actively developing newer, more sophisticated technologies such as surface–acoustic–wave sensors and thin–film detectors.

Monitoring gases in the soil over buried wastes, in atmospheric plumes, and in work areas can utilize both new sensors and new ways of deploying them. Vapor–analysis sensors attached to cone–penetrometer probes can provide information on volatile contaminants in soil. Similar devices can provide valuable data on the atmospheres where buried wastes are being excavated and on the need for robotics.

Monitoring of soil and ground–water contamination can be expedited by new techniques such as electrical resistance tomography and radar holography in addition to standard techniques such as gas chromatography and metal analyses (see "Site Characterization" section above). The goal for new technology development and implementation in this area is to reduce the cost of characterizing plumes and landfills by half in fiscal year 1997. A variety of new alpha– and beta–particle detectors is being developed to assess and map radioactive soil contamination.

Looking to the future, decommissioning and decontamination of storage and waste–treatment facilities will require a variety of techniques to characterize the contamination of surfaces and solids. New tools, such as secondary ion–mass spectroscopy and laser–induced fluorescence techniques may facilitate this work.

The Characterization, Monitoring and Sensors cross–cutting area has outstanding opportunities to contribute to the overall EM program, but two complex, interrelated issues will require continuing management attention:

- *Matching technology development to the needs of the technology implementers.* This task is exceptionally difficult because, on the supply side, there are a multitude of technology developers ranging from large defense contractors, universities, and national laboratories, to small entrepreneurial firms offering unique technologies. An "opportunity and challenge" is to make the best use of the outstanding technological expertise in the programs supported by DOE's Office of Energy Research. On the demand side, there are hundreds of needs at a multitude of sites with only loose coordination among the responsible managements. A hitherto unattained level of cooperation and coordination will be needed to fit all the pieces together optimally.
- *Matching technology development to the evolving needs of the waste management and environmental restoration programs.* The largest current need is probably for technology for site and waste characterization. When the waste–treatment and waste–disposal operations grow larger, there will be major needs for process and workplace monitoring instrumentation. When site–remediation programs are completed, different monitors will be required during the decommissioning and decontamination operations. Long–term monitors will be required to assess the integrity of landfills and waste–storage facilities. Because the design, development, demonstration, and deployment of new monitoring technologies requires periods of years, it is important that the technology–development strategy be phased to anticipate the evolution of the environmental–remediation activities.

Robotics

DOE Needs

Robots with various levels of complexity and sophistication may be necessary to solve many of the DOE–EM problems. The equipment and systems selected are application dependent and will probably depend on funding available at the time of the work. In many instances, due to the hostile environments, simple commercially available teleoperated devices may be justified due to safety reasons for specialized work that is not labor intensive. For large volumes of repeatable work in structured and unstructured environments, such as for D&D tasks, development of specialized automation (robotic and telerobotic devices) may be justified. These developments do not require fundamental research nor new technologies but basically require the adaptation of existing proven systems to specific problems. For some cases (tank–waste retrieval, for example), robotic specialty systems will be required. Demonstration, testing, and evaluation of systems are essential. Although robotics is not a new technology, each new and unique application requires specific engineering and some development work.

Technology Status

Commercial robotic systems are available and currently are being applied to DOE's environmental–restoration and waste–management programs. Typically, robots are computers with mechanical peripheral devices, and robotic–supporting technologies include computer vision, computer graphics, computer architecture, and sensory systems. Much advancement has been made in this area during the past decade. The availability of small, capable, and affordable computers has promoted widespread use of this technology. Computer graphics for robotic control systems provide effective and sophisticated interfaces between humans and robots. A variety of robots is commercially available. Industrial robots (robot arms) are available in a variety of configurations from companies in the United States, Europe, and Japan. Special systems are available for nuclear environments. Mobile robot systems are currently working "around the clock" in security applications for the military, industrial warehouses, and art museums (Everett et al., 1995). Unmanned vehicles have been developed for the DOD (Gage, 1995). Various forms of "pipe crawlers" are commercially available. These systems are generally teleoperated sensor packages used for inspection of interior surfaces, such as pipes and ducts, inaccessible by humans. Teleoperated mobile systems with tracks or wheels are available from several companies. These systems have been applied in a variety of applications, including police operations and nuclear process operations (American Nuclear Society, 1984, 1987, 1989, 1991, 1993, 1995).

DOE Robotics Development Program

The DOE–EM Office of Science and Technology (OST), in cooperation with Morgantown Energy Technology Center (METC), has ongoing projects with industry and academia to develop solutions for DOE–EM problems (USDOE, 1995a,b, in press). The Robotics Technology Development Program (RTDP) is a major technology cross–cutting effort in EM (USDOE, 1993), which is performing applied research and development for all five of DOE's focus areas. The following section focuses on the D&D efforts.

Major emphasis in the RTDP program for D&D is on practical systems and capabilities that can be used in facility deactivation and ongoing surveillance and maintenance activities that will reduce costs, enhance safety, and improve the quality of operations. Four National Laboratories (Oak Ridge National Laboratories, Sandia National Laboratories, Idaho National Engineering Laboratories, and Pacific Northwest Laboratories) and the Savannah River Technology Center are the DOE participants. Six industries and five universities also participate in this program. Major opportunities for robotics have been identified for mapping, characterization, inspection, dismantlement, and decontamination. Current major activities for the program include: a Selective Equipment Removal System (SERS) which is a mobile vehicle system under development for equipment removal in decommissioning operations; the Facility Mapping System (FMS) which is a computer system for the management of characterization data from a facility; and the Mobile Automated Floor Characterization System (MACS) which is an autonomous, mobile floor characterization system for efficient and effective characterization of large floor surfaces, such as the gaseous diffusion plants. The Small Pipe Characterization System (SPCS) and Internal Duct Characterization System (IDCS) will be used to examine remotely interior surfaces for visual inspection and characterization. A Pipe Asbestos Insulation Removal Robot is under development for 4"–8" diameter pipes. A remotely operated vehicle with CO_2 blasting for decontamination of surfaces is under development. This unit will remove paint from surfaces, such as floors in K–25 facilities.

Other cross–cutting efforts are underway. Robotic technologies are being developed and demonstrated (e.g., the Light Duty Utility Arm) for characterization and removal of underground tank waste at Hanford. Laboratory automation development is underway for the analysis of materials from underground storage tanks at Hanford and samples from other process operations. Autonomous robotic systems are under development for the visual inspection of drums of low–level waste stored in warehouses at Fernald, Oak Ridge, Idaho, Rocky Flats, and Hanford.

Related Robotics Development Activities

DOD and NASA have in–house R&D programs in robotics. Research programs, existing at major universities, are addressing robotics technology issues such as unique mechanical configurations, path planning and control, mobile navigation, sensory systems and sensor fusion, computer architecture, real–time systems, computer inspection, hardware and software reliability, and computer graphics. Many of these programs are supported by grants and contracts from DOD, DOE, and NASA. Therefore, benefits from this work are available for DOE applications.

Concerns

Although robotic technology demonstrations and analyses have been budgeted and scheduled for key components of the DOE RTDP, evaluation criteria for the projects and criteria used for budgeting and prioritization of robotics technology projects are not evident. Fiscal Year 1995 funding within EM–50's RTDP supported a demonstration during September 1995 at the ORNL K–25 plant for MACS. That demonstration was not conducted, and, currently, MACS is not an "active" project. This system has been estimated to have high potential for cost savings in facility D&D projects. In Fiscal Year 1995, EM–50's RTDP program had a task entitled The Surveillance and Maintenance Risk and Cost Reduction Evaluation Methodologies (related to robotic systems). The methodology was scheduled to be applied to an existing DOE facility in September 1995, but apparently, that work has not been completed at a specific site.

Although the RTDP appears to have good projects and intentions, it is not clear to CEMT that priorities are ordered correctly to support the overall EM program or if efforts are being made to take advantage of works at other federal agencies.

Separations

Separations, particularly of short–lived radionuclides from long–lived species, play significant roles in dealing with the waste streams considered in the five focus areas, and are especially important in dealing with wastes containing high–level radioactivity. As outlined in the report *Nuclear Wastes: Technologies for Separations and Transmutations* (NRC, 1996), separations would be absolutely critical to the transmutation approach to dealing with either military or nuclear fuel waste materials.

More immediately, however, both the costs and risks of disposing of tank wastes at Savannah River, Hanford and the Idaho National Engineering Laboratory (INEL) (as well as calcined wastes at INEL) are directly related to the efficiency of separations in the wastes to be vitrified (see section on "Vitrification" below) and the number of separation steps required. The latter point can be illustrated by considering options for disposal of tank wastes. One option would be to vitrify the entire contents of the tanks, without any separations, and to dispose of all the waste material in a high–level repository. This option likely would be excessively expensive because of the cost of disposal in a facility such as Yucca Mountain. The cost could be reduced substantially by separation of the radioactive components from the great mass of nonradioactive salts. On the other hand, the cost of disposal could be minimized by complete separation of low–level waste from the high–level material that requires expensive disposal. While this option would be attractive from the viewpoint of disposal costs, it is not feasible because the technology for complete separation does not exist currently.

The optimal balance of processing cost and risk versus disposal cost and risk generally involves a modest number of separations steps. Determining this balance is a major challenge in the proposal that the separations and vitrification processing of the Hanford tank wastes be privatized. If the contractor were to do an inadequate separation of high– and low–level wastes, the cost of high–level storage to be borne by DOE would be excessive.

Beyond the challenge of minimizing costs, the design of separations processes for disposal of tank wastes must also minimize risks to plant personnel and the public. Increases in the number of process steps lead to increased potential for radioactive emissions. Each time a waste stream is moved or processed, the possibility for release of gases, liquids, or solids exists. Each step also generates secondary wastes arising from the reagents used to carry out the desired separations. As with cost, the minimization of risk requires an optimal choice of the number of separations to be performed.

Minimization of cost and risk requires a systems approach to the design of the overall disposal process. The conceptual design of the complete waste treatment system should identify both the number and kinds of separations required. It is likely that many of the newly identified separations processes (such as those for ^{137}Cs and ^{90}Sr discussed below) are not developed sufficiently for immediate application. Prompt identification of the separations needs will facilitate the work of organizations such as EM–50 who are responsible for development of the necessary technology. The development path from identification of a promising chemical separations process through bench–scale and pilot–scale demonstration to actual implementation requires years of effort. However, the resources and time spent on technology development can yield substantial benefits in terms of reduced costs and risks in the ultimate application. These benefits accrue to all stakeholders in the waste–management process from the residents of nearby communities to the U.S. taxpayer (currently, nuclear utility–rate payers), who must, ultimately, bear the cost for disposing of DOE's wastes.

The Efficient Separations and Processing (ESP) cross–cutting area has supported the development of several promising, innovative techniques for separation of cesium and strontium. Approaches for cesium include

- sequestration into high–capacity, layered silicotitanates;
- extraction into ion–specific organic ligands that are encapsulated in permeable polymer membranes; and

- complexation to cobalt dicarbollide ions that are selective for binding Cs and Sr. These complexants may be used either in liquid–liquid extractions or as components of ion exchange resins.

This part of the ESP program has made good use of the expertise of private industry to synthesize developmental quantities of inorganic materials, for proprietary membrane technology, and for ligand design and synthesis. Examples include synthesis of crystalline silicotitanates (CSTs), sodium titanates, and membrane–supported organic extractants that are effective ion–exchange materials for Cs and Sr. These materials, developed under ESP contract, have been brought to pilot scale or commercial production and have been tested on tank wastes or simulants from Savannah River, Oak Ridge, INEL, and Hanford with encouraging results. The CSTs, now commercially available from University of Pennsylvania Molecular Sieves as IONSIV IE–910 and 911, have proven very effective with decontamination factors of one million for Cs and 10,000 for Sr (Brown et al., 1996). Sodium nonatitanate, manufactured as powders or pellets by Allied Signal, Inc. has proven similarly effective for strontium and also appears promising for Am, U, and Pu (Yates et al., 1993). The sodium nonatitanate also has been incorporated in the novel membranes developed by 3M Company, which show mechanical advantages over ion exchange columns in some waste–treatment applications. The 3M Empore™ membranes also have been used with organic ligands tailored for ion specificity by IBC Advanced Technologies (Kafka, 1996). This technology represents another promising example of an ESP initiative that uses the synthesis and manufacturing capability of private industry very effectively. Some of the techniques developed for cesium also appear promising for strontium, although the systems need more development of the strontium separation processes.

To develop an integrated system for separation of the materials contained in complex mixtures such as those in the Hanford tanks, it is desirable that R&D be carried out simultaneously on the various nuclides of interest. For example, one must develop compatible technologies for dealing with technetium and the transuranic elements in addition to cesium and strontium. Technetium is a concern both as a long–lived component of tank wastes and, in other circumstances, as a potential ground–water contaminant. In tank remediation, technetium is a potential source of problems in vitrification. As such, it may possibly require a separate stabilization process to prepare it for long–term storage.

The development of selective techniques for the separation of technetium (mainly TcO_4^-) from waste streams containing high concentrations of other materials appears to be less advanced than for Cs and Sr, but similar extraction and ion–exchange techniques may be applicable if extractants and resins can be developed. For the transuranic elements, further refinement of the TRUEX process may lead to adequate specificity. All these metal–selective processes need to be integrated with each other and with those for priority nonradioactive waste materials.

The ESP program seems to be managed quite effectively. There has been considerable emphasis on understanding specific needs for separations in the remediation of tank wastes and other mixed waste streams. The message that "Success is implementation!" seems to be understood by most of the contractors supported by this program, although the response to the message is probably mixed. Most of the contractors presenting their work at the 1995 ESP Technical Information Exchange appear to have defined useful practical objectives for their R&D programs. Although the ESP program is well run and reasonably successful, two concerns remain.

First, the effectiveness of the interactions between the ESP participants and those supported by the Office of Basic Energy Sciences (BES) and Office of Health and Environmental Research (HER) programs within the Office of Energy Research (OER) can be improved. Considerable progress has been made in strengthening ties to basic research in areas such as design of metal–selective ligands, but major gaps remain in the coordination of the OER programs with those of potential clients in EM–50. Fundamental research relevant to the needs of DOE–EM is done in BES– and HER–supported programs, but coordination of the research directions in these programs with the needs of EM generally is lacking. EM–50 seems well positioned to serve as an interface between the basic–research programs of OER and the technology implementers in EM.

Second, it remains to be demonstrated that innovative developments in separations technology from the ESP program can be moved into the implementation programs of the five major focus areas in a timely and cost–effective manner. As an example, there are obvious problems in replacing the cumbersome tetraphenylborate–based precipitation of cesium in the Savannah River vitrification technology with one of newer cesium separation technologies mentioned above. The time required to replace the tetraphenylborate precipitant with a new inorganic reagent or with an ion–exchange material such as the CSTs described above depends not only on technological requirements, but also on slow, bureaucratic evaluation processes in DOE and in relevant regulatory agencies.

Incineration

The term "incineration" covers a variety of treatment processes that have the common objectives of volume reduction and destruction of organic (usually nonradioactive) components of wastes, but differ in such essential features as temperature, heating system, residence time, furnace design, post–combustion and off–gas purification systems. In the lower temperature ranges (~1000°C), the end product is in the form of loose ash, which may require a secondary treatment for consolidation. At higher temperatures (>1300°C), the end product may be a slag, which may not require any additional form of consolidation or insolubilization.

Common to all forms of incineration, although to very different degrees, is the formation of volatile or semi–volatile components that are vented with the off gases. These volatiles may contain hazardous radioelements (e.g., Cs and Ru) or complex organic components, such as dioxins. However, it should be stressed that emission of the latter can be prevented through optimization of the combustion conditions and the use of an adequate gas–purification system. Volatilities of radionuclides and metals (e.g., Hg) also can be extracted by the gas–purification system.

Because of the potential advantages of incineration (flexibility with regard to feed material, broad range of applications, experience), it would be a mistake to apply to all forms of incineration a generalized "poor–quality" label to be avoided and/or substituted by other, still to be proven, processes. Modern incinerators, adequately designed and operated, can comply completely with the most stringent environmental regulations.

The Subcommittee on Mixed Wastes will contribute to the evaluation of types and operational conditions of incinerators that meet relevant environmental criteria and identify areas for further development, if needed.

Supercritical Water Oxidation (SCWO)

A system based on the use of supercritical fluids (e.g., water at pressure and temperature above the critical point) has been proposed for the destruction of the organic fraction of some mixed wastes (oils, detergents, solvents, complexing chemicals, mixtures of organic residues) (see also USDOE, 1994).

The SCWO process is still being developed, but it offers some potential advantages over high–temperature processes, such as

- easy to handle off gases,
- little or no volatilization of radioactive contaminants, and
- fewer problems of public acceptance.

However, the limitations of SCWO processing include

- corrosion at high temperature and pressure,
- handling of solid residues and precipitates in the supercritical fluid reactor,

- lack of practical experience and knowledge of basic reaction phenomena, and
- concerns about handling toxic substances at high temperature and pressures.

It also should be noted that, if the waste contains significant quantities of radioactive components, the residue requires an adapted form of treatment or immobilization.

Some preliminary impressions of the SCWO process so far are that

- SCWO has to be followed by another immobilization process,
- it is not yet clear for which variety of waste streams the process will be applicable,
- the system appears to be most promising for destruction of organic components in aqueous effluents,
- practical difficulties (corrosion, handling) have to be solved, and
- the practical applicability remains to be demonstrated.

Therefore, although the SCWO processing offers attractive potential, it is doubtful whether it will assume an important role in the handling of radioactive wastes in the short term.

Vitrification

Containment of radioactive materials in glass has been selected by DOE as a versatile, widely applicable approach to the safe and efficient management of high–level radioactive wastes. Major vitrification facilities are in place at the Savannah River and the West Valley sites. Planning is well advanced for a facility at Hanford. Installations are in the early construction stages at the Oak Ridge and Fernald sites.

The potential applications of vitrification to radioactive wastes are very broad, including HLW and LLW from the Hanford waste tanks, in–situ vitrification of wastes in the soil at several sites, and thorium and radium residues at the Fernald Site from extraction of uranium from very rich Belgian Congo ores during the Manhattan Project.

Borosilicate glass has been selected by DOE for production in its vitrification plants. Other potentially useful glasses that might have been chosen include phosphate glass, lead–oxide based glasses, and aluminosilicate–based glasses. Borosilicate glass was chosen because of the broad base of knowledge of its properties as a function of composition, the very large experience base that exists with its use in radioactive waste containment (particularly in France, Germany, and the United

Kingdom), its broad applicability to a variety of wastes, and because of the large investment made in it. This investment is both in dollars and in establishing its acceptance and credibility with policy makers and with the public.

Several significant problems exist with the use of borosilicate or any other type of glass for waste containment. The most important problem is that no performance criteria for the waste form have been promulgated by USNRC. Therefore, no target guidelines for waste–form producers exist. Another severe problem is that a very wide range of waste compositions must be accommodated by any waste–vitrification process. Otherwise, there must be very substantial feed pretreatment to produce a uniform feed to the vitrifier. This problem is most severe with the wastes from the Hanford tanks. If vitrified wastes of a spectrum of compositions are produced, it is necessary to qualify them all for disposal, which is very expensive and time consuming.

Finally, there are several processes that are not vitrification in the usual sense but have the potential to produce vitrified wastes. Examples of these are the Glass Material Oxidation and Dissolution System (GMODS) process being developed at ORNL and the Quantum–CEP™ process developed by the M4 Company.

Disposal

Disposal is an integral—albeit the final—part of any waste–management scheme. The selection of a disposal environment as well as the related engineering structures must be based on objective criteria with regard to type, quantities, volumes and characteristics of wastes. Consequently, these criteria will also be important in the selection of treatment/immobilization processes and the many sub–processes they comprise. The treated material eventually becomes the "source term" in any evaluation of the environmental impact of a waste–management program, which includes societal issues such as inadvertent human intrusion into the waste disposal facility. The types of human intrusion scenarios that are assumed are a matter of policy.

Disposal environment and source term are two closely interacting factors, because they control the solubility and mobility of radioelements and, hence, their eventual impact on population. This is also the case for nonradioactive but hazardous components of wastes. Therefore, recognizing that final evaluations depend on the selection of a site or geologic formation, waste–treatment or conditioning must be considered as part of any waste–disposal program.

Removing hazardous waste materials from an undesirable location (e.g., contaminant plume, disused production or laboratory facilities, unacceptable disposal sites) is often essential. When waste retrieval is required, one must have a clear view of the final destination of the resulting waste materials. Relocation of materials may be a poor practice if it does not solve the ultimate disposal problem.

The foregoing also illustrates the crucial importance of characterizing the treated end products to allow prediction of their behavior in the disposal environment. The inventory of hazardous material is only the first step of characterization. Understanding and quantification of interactions between treated/conditioned wastes and their future disposal environment are at least equally important.

Meeting quantifiable regulatory requirements can be a good guide in evaluating compliance with safety criteria. However, more must be done to ensure that the system as a whole meets basic health and safety risk requirements. Evaluation of the latter is the main objective of case–specific quantitative health and safety risk assessments.

The volume of material for disposal is an important factor in the total cost of a disposal program. In particular, it can be used as a preliminary guideline to select processes for treatment or preconditioning of wastes with the intention of minimizing the volume of waste requiring expensive disposal site preparation and maintenance. Nevertheless, two caveats are important:

- Because of the magnitude of general expenses (for R&D, site selection, administrative and legal procedure, which may be independent of volume and quantity, construction of basic infrastructure, and surveillance), there is not necessarily a linear relation between volume and disposal cost. The issue must be analyzed carefully to determine the relative advantages of putting large efforts in volume reduction prior to treatment and disposal.
- In the case of heat–producing waste, the size of the disposal infrastructure may be determined less by the total volume of waste than by the heat–dissipation capacity of the disposal geologic formation.

Choice of Disposal Sites

The acceptability of a given waste type and waste form in a given disposal site depends on two different evaluation measures:

- the confining power of the natural and engineered barriers, including the waste form, which will prevent the radionuclides or toxic chemicals from being released into the environment for several scenarios, and that will meet the regulatory criteria applicable to the specific disposal site. This confining power may limit both the activity of each waste package and the total capacity of a given site.

- the duration and type of constraints that will be applied to the future land use when disposal is completed. This factor will generally limit the amount of long-lived radionuclides (mostly alpha emitters) that can be accepted in a given waste form, based on various scenarios of future land use (e.g., residential area, road construction site, etc.).

At this stage, it is not clear which of the basic options DOE is considering for the disposal of each type of waste, the constraints that each of these options will put on the maximum loading of the waste (e.g., on alpha emitters), and the confining power of the acceptable waste form.

DOE should establish a list of the disposal options considered for waste disposal, both nationally and at each local site, and the constraints that these options impose on the waste composition. The waste form should then be specified, based on generic and site-specific risk assessments. Existing disposal technologies should be used to make these risk assessments.

For each disposal option, an estimate of the cost of disposal should be made as a function of the total size of each disposal site, because cost is not linearly dependent on the amount of waste.

The adequacy of DOE's options for the safe disposal of wastes generated by each remediation activity needs to be addressed. This adequacy should be evaluated both with the existing (or planned) waste-production technology and characterization and with each new technology that is proposed or developed.

Based on the comparison of the chosen disposal options and waste-acceptance criteria, it is recommended that DOE should produce a plan showing the final destination of each waste type. Such a plan may reveal

- the lack of disposal options for a given waste form;
- the need to optimize disposal site locations to minimize transportation and costs;
- the economic incentive to improve a waste form, a waste-separation technique, or a volume-reduction effort, based on the cost of disposal; and
- the need for improved disposal technology.

Landfills

Many of DOE's cleanup efforts deal with existing landfills that may cause threats to people or the environment. Waste is characterized, and the risk associated with the presence of the waste in the landfill is assessed. If the risk is considered unacceptable, three options are available as discussed in the Landfills Subcommittee report:

- excavation and redisposal elsewhere, possibly after ex–situ treatment of the waste and contaminated soil;
- in–situ treatment (e.g., vitrification, grouting); and
- site confinement by additional engineered barriers such as caps, walls, and floors.

Choosing between these options should be based on criteria for the long–term land use, risk assessment analysis for each option, including risk to workers, and costs.

To put the advantages of each option into perspective, it is essential that the same information be available for the redisposal of the waste (after treatment) in another disposal site, if the excavation option is considered. Therefore, for each landfill reclamation project, DOE should consider potential disposal sites where these risks and costs are known. Until this information is available, the decision for treating a landfill site cannot be complete.

New Technologies for Waste Disposal

The R&D in the area of landfills addresses issues such as confinement or site characterization (geology, hydrology) that are also relevant for the development of new disposal sites. However, DOE should also devote attention to the following areas:

1. Incentives, benefits, and costs of disposal of certain LLW in underground–mined repositories, as is done in Sweden, and planned in the United Kingdom and Germany.

2. Incentives, benefits, and costs of a disposal option where the objective is *not* confinement, but enhanced in–situ treatment of the waste in a "disposal" unit, to remove as much radioactivity or toxicity as possible. New technologies that are studied for in–situ landfill remediations (bioremediation, oxidation, acid leaching, etc.) in specially designed engineered structures (e.g., trenches where the waste can be leached and the liquids collected from below). The concept is that all elements removed from the waste (such as gas or liquids) must be recovered by an engineered system. Instead of being immobilized, the waste form should be easily leachable. All collected effluents should be treated (immobilized in a good matrix form for, for example, deep disposal). This form of "disposal" could be seen as a volume–reduction operation, because the radioactive materials would be recovered and disposed of elsewhere. The disposal treatment site would eventually be turned into a confining

site (e.g., by capping) when the residual level of activity is considered acceptable for the designated land use of the site[14].

Finally, it is recommended that DOE devote considerable attention to defining the needs for air, water, and soil monitoring adjacent to landfills and repositories. Once these needs are defined, it will probably be necessary to focus on development of inexpensive but reliable monitoring techniques for long-term surveillance of disposal sites.

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[14] This concept has been put in operation for a toxic industrial waste site in Montcanin, France, which was closed in 1989 because of unacceptable contamination of the environment (air and water). The site is presently in the construction phase of the drainage system, the capping and leachiong system were installed in 1993. (A description can be found in the work of Marsily, G. de, 1992).

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APPENDIX B

STATEMENTS OF TASK

COMMITTEE ON ENVIRONMENTAL MANAGEMENT TECHNOLOGIES (CEMT)

Statement Of Task

The objective of the Committee is to provide independent review and recommendations to the Department of Energy, Assistant Secretary for Environmental Management (DOE–EM), on environmental management technology developments impacting DOE weapons complex facilities.

The Committee would:

1. Review and evaluate DOE–EM's technology–development programs including guidelines, methodologies, protocols, tests, demonstrations, and applications in the context of the relative importance of problems facing DOE–EM;
2. Identify, review, and recommend as appropriate new technical criteria and emerging technologies in environmental management relevant to DOE–EM;
3. Review technology transfer and commercialization for technology programs in DOE–EM; and
4. Issue reports, recommendations, and options on DOE–EM's technology development.

A key function of the Committee would be to ensure that a set of activities from basic research through commercialization is encouraged and promoted. The Committee would also address issues and resolutions of problems related to the development and use of technologies for environmental management.

The Committee would operate on a continuing basis. It would consist of about 15 members of international reputation with strong backgrounds in disciplines relevant to environmental management technologies. The Committee would meet quarterly or more frequently if required.

During March of every year, the Committee would submit a peer–reviewed report to the Assistant Secretary for DOE–EM, listing specific conclusions and recommendations of the studies which the Committee has undertaken during the year. The Committee would also prepare topical reports, if timeliness requires it.

DOE–EM will receive 20 copies of each report, additional copies will be provided to the NRC Committee members and other parties in accordance with NRC policy. These reports would be made available to the public without restriction.

SUBCOMMITTEE ON CONTAMINANT PLUMES

Statement Of Task

The Subcommittee on Contaminant Plumes is established with a view to assist the Committee on Environmental Management Technologies (CEMT) as one of the five major focus areas.

The subcommittee will review the DOE documentation including (1) DOE's Remedial Action Program Information Center (RAPIC) bibliography, (2) EPA's Cleanup Information (CLU–IN), (3) Vendor Information System for Innovative Treatment Technologies (VISITT), and (4) Alternative Treatment Technology Information Center (ATTIC) Bulletin Board. The subcommittee also will review the pertinent technical literature, and consult with experts in the field to ensure that state–of–the–art documentation is available on the different technical issues and developments involved in contaminant plumes remediation. If not already available, the subcommittee shall prepare a report including the advantages and disadvantages of each method including cost and risk reduction as well as sensitivity to cleanup levels and time constraints.

The subcommittee will identify the greatest needs in the focus area and the reasons for identifying the technologies being developed. It should identify the difficulties in bringing the technologies being developed to fruition. The subcommittee will further address potential for industrial applications and pay–offs of the technologies being developed to DOE and industry, including foreign markets. The subcommittee should also identify new technologies which have scope for development. It should recommend actions as to what else should be done and how to accelerate the process. This information should be presented as a report to the parent committee.

The subcommittee as a whole, or its members separately, will visit representative DOE Weapons Complex facilities to get first hand information and interact with scientists working at the sites.

Topical reports as indicated above, as appropriate, and minutes of the subcommittee meetings, will be submitted as inputs to the work of CEMT. The subcommittee chairman will provide an annual report to CEMT on December 1st every year.

SUBCOMMITTEE ON DECONTAMINATION AND DECOMMISSIONING

Statement Of Task

The Subcommittee on Decommissioning and Decontamination is established with a view to assist the Committee on Environmental Management Technologies (CEMT) as one of the five major focus areas.

The subcommittee will review the DOE documentation including (1) DOE's Remedial Action Program Information Center (RAPIC) bibliography, (2) EPA's Cleanup Information (CLU–IN), (3) Vendor Information System for Innovative Treatment Technologies (VISITT), and (4) Alternative Treatment Technology Information Center (ATTIC) Bulletin Board. The subcommittee also will review the pertinent technical literature, and consult with experts in the field to ensure that state–of–the–art documentation is available on the different technical issues and developments involved in decontamination and decommissioning of weapons complex facilities. If not already available, the subcommittee shall prepare a report including the advantages and disadvantages of each method including cost and risk reduction as well as sensitivity to cleanup levels and time constraints.

The subcommittee will identify the greatest needs in the focus area and the reasons for identifying the technologies being developed. It should identify the difficulties in bringing the technologies being developed to fruition. The subcommittee will further address potential for industrial applications and pay–offs of the technologies being developed to DOE and industry, including foreign markets. The subcommittee should also identify new technologies which have scope for development. It should recommend actions as to what else should be done and how to accelerate the process. This information should be presented as a report to the parent committee.

The subcommittee as a whole, or its members separately, will visit representative DOE Weapons Complex facilities to get first hand information and interact with scientists working at the sites.

Topical reports as indicated above, as appropriate, and minutes of the subcommittee meetings, will be submitted as inputs to the work of CEMT. The subcommittee chairman will provide an annual report to CEMT on December 1st every year.

SUBCOMMITTEE ON HIGH–LEVEL WASTE IN TANKS

Statement Of Task

The Subcommittee on High–Level Waste Tanks is established with a view to assist the Committee on Environmental Management Technologies (CEMT) as one of the five major focus areas.

The subcommittee will review the DOE documentation including (1) DOE's Remedial Action Program Information Center (RAPIC) bibliography, (2) EPA's Cleanup Information (CLU–IN), (3) Vendor Information System for Innovative Treatment Technologies (VISITT), and (4) Alternative Treatment Technology Information Center (ATTIC) Bulletin Board. The subcommittee also will review the pertinent technical literature, and consult with experts in the field to ensure that state–of–the–art documentation is available on the different technical issues and developments involved in high–level waste tanks remediation. If not already available, the subcommittee shall prepare a report including the advantages and disadvantages of each method including cost and risk reduction as well as sensitivity to cleanup levels and time constraints.

The subcommittee will identify the greatest needs in the focus area and the reasons for identifying the technologies being developed. It should identify the difficulties in bringing the technologies being developed to fruition. The subcommittee will further address potential for industrial applications and pay–offs of the technologies being developed to DOE and industry, including foreign markets. The subcommittee should also identify new technologies which have scope for development. It should recommend actions as to what else should be done and how to accelerate the process. This information should be presented as a report to the parent committee.

The subcommittee as a whole, or its members separately, will visit representative DOE Weapons Complex facilities to get first hand information and interact with scientists working at the sites.

Topical reports as indicated above, as appropriate, and minutes of the subcommittee meetings, will be submitted as inputs to the work of CEMT. The subcommittee chairman will provide an annual report to CEMT on December 1st every year.

SUBCOMMITTEE ON LANDFILLS

Statement Of Task

The Subcommittee on Landfills is established with a view to assist the Committee on Environmental Management Technologies (CEMT) as one of the five major focus areas.

The subcommittee will review the DOE documentation including (1) DOE's Remedial Action Program Information Center (RAPIC) bibliography, (2) EPA's Cleanup Information (CLU–IN), (3) Vendor Information System for Innovative Treatment Technologies (VISITT), and (4) Alternative Treatment Technology Information Center (ATTIC) Bulletin Board. The subcommittee also will review the pertinent technical literature and consult with experts in the field to ensure that state–of–the–art documentation is available on the different technical issues and developments involved in landfill stabilization. If not already available, the subcommittee shall prepare a report including the advantages and disadvantages of each method including cost and risk reduction as well as sensitivity to cleanup levels and time constraints.

The subcommittee will identify the greatest needs in the focus area and the reasons for identifying the technologies being developed. It should identify the difficulties in bringing the technologies being developed to fruition. The subcommittee will further address potential for industrial applications and pay–offs of the technologies being developed to DOE and industry, including foreign markets. The subcommittee should also identify new technologies which have scope for development. It should recommend actions as to what else should be done and how to accelerate the process. This information should be presented as a report to the parent committee.

The subcommittee as a whole, or its members separately, will visit representative DOE Weapons Complex facilities to get first hand information and interact with scientists working at the sites.

Topical reports as indicated above, as appropriate, and minutes of the subcommittee meetings, will be submitted as inputs to the work of CEMT. The subcommittee chairman will provide an annual report to CEMT on December 1st every year.

SUBCOMMITTEE ON MIXED WASTES

Statement Of Task

The Subcommittee on Mixed Wastes is established with a view to assist the Committee on Environmental Management Technologies (CEMT) as one of the five major focus areas.

The subcommittee will review the DOE documentation including (1) DOE's Remedial Action Program Information Center (RAPIC) bibliography, (2) EPA's Cleanup Information (CLU–IN), (3) Vendor Information System for Innovative Treatment Technologies (VISITT), and (4) Alternative Treatment Technology Information Center (ATTIC) Bulletin Board. The subcommittee also will review the pertinent technical literature and consult with experts in the field to ensure that state–of–the–art documentation is available on the different technical issues and developments involved in mixed wastes characterization, treatment, and disposal. If not already available, the subcommittee shall prepare a report including the advantages and disadvantages of each method including cost and risk reduction as well as sensitivity to cleanup levels and time constraints.

The subcommittee will identify the greatest needs in the focus area and the reasons for identifying the technologies being developed. It should identify the difficulties in bringing the technologies being developed to fruition. The subcommittee will further address potential for industrial applications and pay–offs of the technologies being developed to DOE and industry, including foreign markets. The subcommittee should also identify new technologies which have scope for development. It should recommend actions as to what else should be done and how to accelerate the process. This information should be presented as a report to the parent committee.

The subcommittee as a whole, or its members separately, will visit representative DOE Weapons Complex facilities to get first hand information and interact with scientists working at the sites.

Topical reports as indicated above, as appropriate, and minutes of the subcommittee meetings, will be submitted as inputs to the work of CEMT. The subcommittee chairman will provide an annual report to CEMT on December 1st every year.

APPENDIX C

BIOGRAPHICAL SKETCHES OF COMMITTEE AND SUBCOMMITTEE MEMBERS

BAISDEN, Patricia A.—Dr. Baisden received her B.S. in 1971, and her Ph.D. in chemistry in 1975 from Florida State University. Her research interests focus on measurement of heavy–element fission properties using both chemical and on–line techniques, solution chemistry of lanthanide and actinide elements, and heavy–ion collisions leading to complete or incomplete fusion. Since 1981, Dr. Baisden has worked for the Lawrence Livermore National Laboratory in Livermore, California. She is currently a Division Leader in Chemistry & Materials. Her expertise is in nuclear chemistry and radiochemistry, inorganic and analytical chemistry, and actinide chemistry. Dr. Baisden's memberships include the American Physical Society, the American Chemical Society, and Sigma Xi.

BAUGH, Kent D.—Dr. Baugh earned a Ph.D. in environmental engineering in 1983. Since 1991, he has been employed at OHM Remediation Services Corporation, where he is manager for technical services. In addition, he has 18 years' experience in management design, construction, and operation of remedial actions for a wide variety of contaminants, including metals, PCBs, pesticides, VOCs, POL, radionuclides, and acid/bases. His remediation experience includes design and implementation of in–situ and ex–situ remediation treatment technologies.

BEDIENT, Philip E.—Dr. Bedient received a B.S. in physics, an M.S. in environmental engineering, and a Ph.D. in environmental engineering sciences from the University of Florida. His research interests include computer modeling of contaminant transport in surface and ground water systems, and the development of decision support systems for site remediation. Dr. Bedient is currently a professor and Chair of the Department of Environmental Engineering at Rice University, Houston, Texas. He held the Shell Distinguished Chair in Environmental Science from 1988–1993 and directed the development and application of the BIOPLUME II program for modeling aerobic biodegradation of organic contaminants in ground water. Dr. Bedient has written over 100 articles and co–authored three textbooks.

BIER, Vicki M. —Dr. Bier earned her B.S. from Stanford University in 1976 and her Ph.D. from the Massachusetts Institute of Technology in 1983. Her specialties include operations research and risk assessment. Dr. Bier is an associate professor in the Department of Industrial Engineering and the Department of Nuclear Engineering & Engineering Physics at the University of Wisconsin, where she has been since 1989. From 1982 to 1989 she worked in risk assessment of nuclear power plants for Pickard Lowe & Garrick, Inc. Dr. Bier's memberships include the Institute for Operations Research and Management Science and the Society for Risk Analysis. Her research interests focus on operations research and the treatment of uncertainty in estimation and decision making.

BROWN, Kirk W.—Dr. Brown has a B.S. from Delaware Valley College, an M.S. from Cornell University, and a Ph.D. from the University of Nebraska. His research has focused on the land disposal of wastes and the cleanup of sites contaminated with agricultural and industrial chemicals. Dr. Brown has written several books and over 175 technical articles. He is currently a professor of soil science at Texas A&M University in College Station and is also a member of the faculty of toxicology. In 1981, Dr. Brown founded an environmental science and engineering consulting firm, and he now serves a consultant through K.W. Brown Environmental Services. He has served on several EPA, Office of Technology Assessment, and National Research Council committees. He has received numerous awards from Texas A&M University and from his professional societies.

BURSTEIN, Sol—Dr. Burstein received a B.S.M.E. degree from Northeastern University and a D.Sc. (hon) from the University of Wisconsin at Milwaukee. He is a registered professional engineer and member of the National Academy of Engineering. He retired in 1987 as Vice Chairman of the Board of Directors of Wisconsin Energy Corporation, the holding company for Wisconsin Natural Gas Company and Wisconsin Electric Power Company, of which he also served as Vice President and Director. His career with Wisconsin Electric spanned 21 years, prior to which he spent over 19 years in engineering design and construction work at Stone & Webster. He currently is an independent consultant specializing in utility management and nuclear and mechanical engineering. He has served on numerous industry and government advisory committees and is a member of the National Research Council's Board on Radioactive Waste Management.

BYRD, Joseph S.—Professor Byrd received his B.S. and M.S. in Electrical Engineering from Clemson University and the University of South Carolina, respectively. He joined the faculty of the University of South Carolina in 1989 and is currently Professor of Electrical and Computer Engineering. For the previous 28 years he held various positions at the DuPont Savannah River Laboratory, Aiken, South Carolina, where he managed the Engineering Development Group, organized and managed the Robotics Technology Group that realized the first robotics applications at the Savannah River Site, and conducted and managed R&D in mobile robotics. His professional activities include South Carolina Society of Professional Engineers, Robotics and Remote Systems Division of the American Nuclear Society (past Chair), Editorial Advisory Board for *RadWaste Magazine,* and a previous member of the Waste Management External Advisory Committee and Single–Shell Tank Retrieval Technology Panel (organizer and Chair) for Westinghouse Hanford Company. His current research is in the area of mobile robotics. He is Principal Investigator and Project Manager for an autonomous inspection robotic system for stored low–level radioactive waste. In addition to his research, Mr. Byrd has received two teaching awards. He has made numerous presentations as well as written many publications on robotics and computer technology. He is also co–author of a textbook on computer architecture. Professor Byrd has received two teaching awards.

CARTER, Melvin W.—Dr. Carter received his B.S. degree in civil engineering, his M.S. in public health engineering from the Georgia Institute of Technology, and, his Ph.D. in radiological health from the University of Florida. He is Neely Professor Emeritus of Nuclear Engineering and Health Physics at the Georgia Institute of Technology in Atlanta. He specializes in public health engineering and radiation protection. Before joining the faculty at Georgia Institute of Technology, he had extensive experience in radiological health with the U.S. Public Health Service and the EPA. He served as director of several major government laboratories, including the National Environmental Research Center in Las Vegas (1968–1972). Dr. Carter is a former President of the International Radiation Protection Association and the Health Physics Society. He serves and has served on numerous advisory committees and boards, including the National Research Council's Board on Radioactive Waste Management. He is an Honorary Member of the National Council on Radiation Protection and Measurements and serves as Chairman Emeritus of its Scientific Committee 64 on Environmental Issues. Dr. Carter continues to consult with international agencies, governmental organizations, businesses, and industry.

CLARKE, Ann N.—Dr. Clarke holds Masters degrees from Johns Hopkins University in chemistry and earth sciences and a Ph.D. from Vanderbilt University in chemistry with a minor in environmental engineering. Currently, she is Director of the Remedial Technologies Development Division for ECKENFELDER INC., Nashville, Tennessee. Her areas of expertise include Part B permitting, RCRA compliance training, environmental fate and transport of chemicals, development sampling and analysis programs for trace level organics, mathematical modeling, and Phase I Assessments and Compliance Audits throughout the United States and abroad. She directed multiple activities under contract to the USEPA–CERI program, served as a Director of the National Environmental Training Association and was 1989 Educator of the Year, and currently serves on the Scientific Review Panel for the National Library of Medicine's Hazardous Substances Data Bank. For the last decade, Dr. Clarke has directed research on the design and development of innovative technologies for the remediation of soil, ground water, and air at hazardous waste sites. Dr. Clarke is the author of over 100 technical reports, papers, and books.

CLEMENS, Bruce W.—Mr. Clemens is currently a member of the Energy, Environment, and Resources Center at the University of Tennessee, Knoxville, where he is leading a task to establish standards for radioactive scrap metal. His current research efforts focus on how organizations address environmental initiatives. Mr. Clemens has managed major, multimillion dollar environmental programs around the world. While with the U.S. Environmental Protection Agency, Mr. Clemens was responsible for the first guidance on Remedial Investigations and Feasibility Studies. Mr. Clemens has acted as a consultant for federal, state, and international organizations. He has served on various national and international task forces on subjects including hazardous–waste management, disaster relief assistance, and public water supply, and has served as a technical expert in court cases.

CONWAY, Richard A.—Mr. Conway earned his B.S. at the University of Massachusetts and his M.S. in civil engineering at the Massachusetts Institute of Technology. In 1954, Mr. Conway began his career in the U.S. Army as an assistant preventive medical officer, and in 1957, he joined Union Carbide Corporation as a development engineer, where he is now a Senior Corporate Fellow. He has received many honors and awards, such as the Hering Medal, Gascoigne Medal, Dudley Medal, Rudolfs Medal and honors from the American Society of Civil Engineers and the American Society for Testing and Materials. Mr. Conway is a member of the National Academy of Engineering, American Society of Civil Engineers, the Water Environment Association, Sigma Xi, Association of Engineering Professors, Society for Environmental Toxicology and Chemistry, and the American Academy of Environmental Engineers. His research interests include, contaminated site remediation, hazardous waste management, and risk analysis related to chemicals in the environment.

COTTON, Thomas A.—Dr. Cotton received a B.S. in electrical engineering from Stanford University, an M.S. in philosophy, politics, and economics from Oxford University, and a Ph.D in engineering–economic systems from Stanford University. He is vice president of JK Research Associates, Inc. where he is a principal in activities related to radioactive–waste–management policy and strategic planning. Before joining JK Research Associates, he dealt with energy policy and radioactive–waste–management issues as an analyst and project director during nearly 11 years with the Congressional Office of

Technology Assessment. His expertise is in public policy analysis, nuclear waste management, and strategic planning.

CRIMI, Frank, P.—Mr. Crimi completed a B.S. in mechanical engineering at Ohio University in Athens in 1951, and did graduate studies in mechanical engineering at Union College, Schenectady, New York, from 1957 to 1959. He has been employed in the Environmental Management Division of Lockheed Martin Environmental Systems since 1992. Mr. Crimi has 33 years of experience and maintenance of DOE naval nuclear reactor plants with special emphasis in decontamination and decommissioning of nuclear plants and facilities. He was the General Electric project manager for the Shippingport Atomic Power Station decommissioning. He chaired the Long Island Power Authority's independent review panel during the decommissioning of the Shoreham Nuclear Power Station and is a member of the public service of Colorado's Management Oversight Committee for the Fort Saint Vrain Nuclear Generating Station decommissioning.

CROFF, Allen G.—Mr. Croff has a B.S. in chemical engineering from Michigan State University, a nuclear engineering degree from the Massachusetts Institute of Technology, and an M.B.A. from the University of Tennessee. He is Associate Director of the Chemical Technology Division at Oak Ridge National Laboratory (ORNL). His areas of expertise include initiation and technical management of research and development involving waste management, nuclear fuel cycles, transportation, conservation, and renewable energy. Since joining ORNL in 1974, he has been involved in numerous technical studies on waste management and nuclear fuel cycles, and his duties have included supervising and participating in the updating, maintenance, and implementation of the ORIGEN–2 computer code; developing a risk–based, generally applicable radioactive–waste classification system; developing and assessing multidisciplinary studies of actinide partitioning and transmutation; and leading and participating multidisciplinary national and international technical committees.

DAVIS, Gary A.—Mr. Davis has a chemical engineering degree from the University of Cincinnati and a law degree from the University of Tennessee. He is the Director of the University of Tennessee Center for Clean Products and Clean Technologies, an interdisciplinary research center focusing on the earliest stages of pollution prevention. His research includes life-cycle environmental impacts of products, substitutes for polluting products, and policies to encourage the use of cleaner products and processes. The Center conducts research for the EPA, an environmental labeling organization, Green Seal, and other companies. Mr. Davis has been working on technical and policy issues related to pollution prevention and hazardous substance management for over 15 years. He is also an Adjunct Professor of Environmental Law at the University of Tennessee College of Law. Prior to his position at the Center, Mr. Davis was a hazardous–waste policy advisor with the California Governor's Office, and a practicing chemical engineer with an environmental consulting firm developing pollution–prevention technologies for industry.

DEJONGHE, Paul—After completing his undergraduate degree from Ghent University in 1949, Dr. Dejonghe received his doctorate degree in 1960. He is currently emeritus professor of Leuven University and general advisor to the chairman of the board of the nuclear research center at Mol, Belgium. During his career, he has served as member or chairman of several international committees on radioactive–waste management of Euratom/E.C., the OECD and IAEA. Dr. Dejonghe's professional career took place mainly at the Nuclear Research center at Mol, where he held positions in radioactive–waste management, and served as both assistant general manager and acting general manager. Simultaneously, he was part–time professor at the University of Leuven, Belgium, Faculty of Applied Sciences. He was a founding member of the company INDAVER for the management of hazardous wastes in the port–area of Antwerp.

de MARSILY, Ghislain—Dr. de Marsily graduated as a mining engineer from the Paris School of Mines in 1963 and received a Doctorate of Science in 1978 from the University of Paris. He has been professor of Applied Geology at the University of Paris VI since 1987 and is also professor at the Paris School of Mines. Dr. de Marsily was Head of the Hydrogeology group at the Paris School of Mines from 1973 to 1987. He is a member of the advisory group of the French Nuclear Safety Authorities, and of the National Committee for Evaluation of Research in Nuclear waste disposal. He has also served on advisory panels for geologic disposal at the European Commission, the Swedish Nuclear Power Inspectorate, the Swiss Paul Scherer Institute, and Sandia National Laboratories for the WIPP project.

DORNSIFE, William P.—Mr. Dornsife graduated from the U.S. Naval Academy in 1966. After his naval service, he received an M.S. degree in nuclear engineering from Ohio State University. He began working for the Pennsylvania Bureau of Radiation Protection in 1976 as a nuclear engineer, and then held the position of Chief of the Nuclear Safety Division. He was responsible for managing the Nuclear Safety Program and the Low–Level Radioactive Waste (LLRW) Program. Mr. Dornsife is currently the Director of the Pennsylvania Bureau of Radiation Protection. Mr. Dornsife is a registered professional engineer in the Commonwealth of Pennsylvania and participates nationally in a variety of LLRW and other radiation issues. He is an elected member of the National Council on Radiation Protection and Measurements (NCRP). He chairs the EPA NACEPT Subcommittee on Radiation Cleanup Regulation, and is a member of various National Research Council and USDOE oversight panels. He is a full member of the Conference of Radiation Control Program Directors (CRCPD) and serves on its Executive Board as Chairperson Elect.

DRUMMOND, Marshall E.—Dr. Drummond holds an M.B.A. in marketing and economics from San Jose State University, a B.S. in management from Colorado State University, a doctor of education degree in higher–education administration, organization, and leadership from the University of San Francisco. He has been president of Eastern Washington University since 1990. Dr. Drummond began service at Eastern Washington in the mid–1980's as vice president for administrative services and as executive vice president, responsible for all aspects of internal management at the university. He is a founding member of and was general manager of Technology Specialists, Inc. in Exton, Pennsylvania, 1985–1989. In 1992 he became chair of the Hanford Future Use Working Group. Dr. Drummond is a member of several national honor societies and has published many works in professional journals relating to his academic discipline and higher–education management.

EXNER, Jurgen H.—Dr. Exner received his BS degree from the University of Minnesota in 1963, and his Ph.D. at the University of Washington in 1968. He is the principal and president of JHE Technology Systems, Inc., a consulting firm he formed in 1992. Prior to that, he was senior vice president, Technical Development and Analytic Services, OHM Corporation, and held various positions with OHM Corporation, IT Corporation, IT, Environscience, Hydrosciences, and Dow Chemicals. He is a member, and Chair, Division of Environmental Chemistry, of the American Chemical Society. From 1986–1988, Dr. Exner was a lecturer for the Environmental Protection Agency Seminar on

RCRA/CERCLA, and has participated in many national and international conferences and workshops. Dr. Exner holds numerous patents. He is also the Associate Editor of the *Journal of the Air and Water Control Federation.*

FJELD, Robert A.—Dr. Fjeld holds a Ph.D. in nuclear engineering from the Pennsylvania State University. He is currently the Dempsey Professor of Waste Management in the Department of Environmental Systems Engineering at Clemson University, where he coordinates a graduate–level program on the environmental aspects of nuclear technologies. His research efforts are focused on environmental restoration and waste–management activities, and he has done consulting in operational health physics, risk assessment, radioactive decontamination and aerosol filtration. Dr. Fjeld is active in the American Society of Mechanical Engineers (ASME) Mixed Waste Committee, serving as Chairman of the Education/Information Subcommittee, and is a member of the Health Physics Society and the American Nuclear Society.

FOUNTAIN, John C..—Dr. Fountain completed his Ph.D. in geology at the University of California in Santa Barbara in 1975. He joined the faculty of the State University of New York, Buffalo, in 1975. Currently, he is an associate professor of geology there—a position he has held since 1980. As a geochemist, Dr. Fountain's research has focused on contaminant hydrology, specifically aquifer remediation and characterization of fractured rock aquifers. He is a member of the Geological Society of America, the American Geophysical Union, and the National Ground Water Association.

GARRICK, B. John—Dr. Garrick received his Ph.D. in engineering and applied science from the University of California, Los Angeles, and is a graduate of the Oak Ridge School of Reactor Technology. He is Chairman of PLG, Inc., an international engineering, applied science, and management consulting firm. Dr. Garrick is a member of the National Academy of Engineering and is a Fellow of the American Nuclear Society, the Society for Risk Analysis, and the Institute for the Advancement of Engineering. He is Vice–Chair of the National Research Council's Board on Radioactive Waste Management. In 1993, Dr. Garrick was appointed to the U.S. Nuclear Regulatory Commission's Advisory Committee on Nuclear Waste, of which he is now the Vice Chairman. He is a past president of the Society for Risk

Analysis, an international society, and in 1994, received that society's highest honor, the Distinguished Achievement Award, for his contribution to the science of risk analysis. Dr. Garrick has published approximately 200 papers and reports on risk, reliability, engineering, and technology.

GULAS, Victor G.—Dr. Gulas completed his Ph.D. in sanitary engineering at Virginia Polytechnic Institute & State University. He is a senior vice president at Montgomery Watson, in Boulder, Colorado, in charge of innovation and technology for the company's industrial/hazardous waste operations. His experience includes design and research work in biological processes, such as activated sludge, aerobic and anaerobic digestion; trickling filters; and waste–stabilization ponds with physical–chemical processes. He has served as project manager for the process development of a wastewater treatment plant upgrade for a major chemical manufacturer, principal–in–charge of a large remedial investigation/feasibility study for an 880–acre abandoned refinery site in Louisiana, project manager third–party oversight of a PCB–contaminated underground cleanup at the Savannah River Plant in South Carolina, and project manager on a remedial action plan for a dump site containing 100 to 200 55–gallon drums. Dr. Gulas also managed an industrial wastewater treatment process development and directed the predesign of three industrial wastewater treatment plants.

KINTNER, Edwin E.—Mr. Kintner received a B.S. from the U.S. Naval Academy and an M.S. in nuclear physics and in marine engineering, from MIT. He was executive vice president of General Public Utilities (GPU) Nuclear Corporation and member of its Board of Directors for seven years until his retirement in June 1990. During that time, he was the corporate official responsible for the cleanup of the TMI–2 reactor accident. His background includes many years of nuclear reactor experience both with the military and private industry. He was chair of the Nuclear Power Division Advisory Committee and chair of the Advanced Light Water Reactor Utility Steering Committee, which reconceptualized the next generation of reactors. In addition, he was a member of the Massachusetts Institute of Technology's Corporation Visiting Committee for Nuclear Engineering. He is a member of the National Academy of Engineering and the American Nuclear Society. Mr. Kintner chaired the National Research Council's Transmutation Subcommittee four–year study of Separations and Transmutation of Radioactive Wastes. Prior to joining GPU, he was director of the U.S.

Magnetic Fusion Program at the USDOE and its predecessor agency. In previous years, he was assistant director for reactor engineering and then deputy director of the former Atomic Energy Commission's Reactor Development Division. Among awards received during his career are the Secretary of the Navy Commendation Medal, the title of Distinguished Alumnus of MIT, and the highest award of the Senior Executive Service. Mr. Kintner represented the United States as chair of the U.S./ U.S.S.R. Joint Fusion Power Coordinating Committee and chair of the U.S/Government of Japan Fusion Power Coordinating Committee.

MYERS, Peter B.—Dr. Myers served in World War II with the U.S. Navy before completing his doctorate in nuclear physics as a Rhodes Scholar at Oxford University. He retired in 1993 after 14 years as director of the National Research Council's Board on Radioactive Waste Management. Dr. Myers has held management positions with responsibility for research and development of advanced solid-state technology at Bell Telephone Laboratories, Motorola, the Martin Company, Bunker Ramo, and Magnavox. Dr. Myers is a fellow of both the Institute of Electrical and Electronic Engineers, and the American Association for the Advancement of Science. He was a founding member of the Institute of Management Sciences and is a member of the American Nuclear Society, the American Physical Society, and the Materials Research Society.

PARKER, Frank L.—Dr. Parker received his B.S. from the Massachusetts Institute of Technology and Ph.D. from Harvard University. He is a Distinguished Professor of Environmental and Water Resources Engineering at Vanderbilt University, where he has been a professor since 1967. He also serves as the Westinghouse distinguished professor at Clemson University. He is a member of the American Geophysical Union, the American Nuclear Society, the Society for Risk Analysis, the Health Physics Society, and the American Association for the Advancement of Science. Dr. Parker is a senior researcher at the International Institute for Applied Systems Analyses and is a member of several environmental advisory committees, including the Environmental Management Advisory Board of the Department of Energy. Dr. Parker is a member of the National Academy of Engineering, and chaired the National Research Council's Committee on Environmental Management Technologies from its inception in 1994 to September 1995. Formerly, he was the Chairman of the

National Research Council's Board on Radioactive Waste Management.

PARSHALL, George W.—Dr. Parshall received his B.S. in chemistry from the University of Minnesota in 1951 and his Ph.D. in organic chemistry from the University of Illinois in 1954. He was Director of Chemical Science in the Central Research & Development Department of the DuPont Company from 1979 until his retirement at the end of 1992. He started work as a research chemist in the Department in 1954 and was promoted to Research Supervisor in 1965 where he was in charge of a group in organometallic chemistry and homogeneous catalysis until 1979. Since retirement, he has consulted for DuPont and has been involved in a number of advisory activities through the National Research Council. Dr. Parshall is a member of the National Academy of Sciences and of the American Academy of Arts and Sciences. He received two major American Chemical Society Awards: the ACS Award in Inorganic Chemistry, and the Barnes Award for Leadership in Chemical Research Management. He has published two books.

POHLAND, Frederick G.—Dr. Pohland received his B.S. in civil engineering from Valparaiso University and, after a period of employment as an engineer with the Erie Railroad Company, completed military service with the U.S. Army and graduate studies at the M.S. and Ph.D. levels in environmental engineering at Purdue University. His research has focused on environmental engineering operations and processes, solid– and hazardous waste management, and environmental impact monitoring and assessment. Dr. Pohland began his career at the Georgia Institute of Technology, and most recently, at the University of Pittsburgh, where he is Professor and Edward R. Weidlein Chair of Environmental Engineering. In addition to his academic appointments, Dr. Pohland has been a Visiting Scholar at the University of Michigan and a Guest Professor at the Delft University of Technology in The Netherlands. Some of his memberships include the National Academy of Engineering, American Water Works Association, Water Environment Federation, American Chemical Society, and the International Association on Water Quality. He is a Diplomate and Past President of the American Academy of Environmental Engineers.

PRESLO, Lynne M.—Ms. Preslo holds an M.S. in hydrogeology from Stanford University. Currently, she is the Senior Vice President for Technical Programs at Earth Tech in Berkeley, California. Prior to Earth Tech, she held the position of vice president for the earth–science practice of ICF–Kaiser Engineers. During the last eight years, she has served as the principal hydrogeologist and project director on five major ground–water remediation projects in California and co–authored a book on in–situ and ex–situ remedial technologies. She also served on an expert advisory panel regarding ground–water and soil cleanup policies, perspectives, and future trends for the Environmental Protection Agency's Office of Research and Development. Ms. Preslo served as a member of the National Research Council's Committee on Ground–Water Cleanup Alternatives.

ROBERTS, Paul—Dr. Roberts received a B.S in chemical engineering from Princeton University in 1960, an M.S. in environmental engineering from Stanford University in 1971, and a Ph.D. in chemical engineering from Cornell University in 1966. He is currently a professor of environmental engineering at Stanford University and researches contaminant transport in porous media. Previously, he headed the Engineering Department of the Swiss Federal Institute of Water Supply and Water Pollution Control. Also, he has worked as a research engineer at Stanford Research Institute and a process engineer at Chevron Research Company.

ROGERS, Vern C.—Dr. Rogers received his Ph.D. in nuclear engineering from the Massachusetts Institute of Technology in 1969. He also holds a B.S. degree in physics and an M.S. degree in mechanical engineering (nuclear) from the University of Utah in 1965. He received an M.B.A. from the University of Phoenix in 1992. He is President of Rogers and Associates Engineering Corp—a technical consulting company focusing on radioactive– and hazardous–waste management He is a Fellow of the American Nuclear Society and is a member of the Health Physics Society, the American Physical Society, and the American Institute of Chemical Engineers. Dr. Rogers also is a Certified Health Physicist and a Registered Professional Engineer. Prior to forming Rogers and Associates in 1980, he was Vice President and Manager of Nuclear and Advanced Programs at Ford, Bacon & Davis Utah, Inc. Dr. Rogers co–developed the analytical and laboratory methodology for designing and evaluating covers for impoundments of radium–containing wastes.

SOMBRET, Claude G.—Dr. Sombret was born and educated in Paris. He holds a Ph.D. in ceramics. Dr. Sombret joined the Commissariat à l'Energie Atomique (CEA) in 1957, where he held several positions until his retirement in 1994. Currently, Dr. Sombret is working as a consultant and resides in Villeneuve–Lès–Avignon, France. He has been involved in R&D in the field of waste management and has conducted research on the specification of the French nuclear waste glasses, as well as on processes of industrial interest dealing with high–level vitrification..One of these processes is now implemented in the French vitrification facilities at Marcoule (AVM) and at La Hague (R7 and T7) and at Sellafield, UK (WVP). He played a major role in the design of AVM and participated in the design of R7 and T7. Dr. Sombret has published articles in French, American, and British journals and has presented over fifty papers at various symposia. He is a member of many societies and associations including the American Nuclear Society, the American Ceramic Society, and the Materials Research Society.

STEINDLER, Martin J.—Dr. Steindler holds a Ph.D. in chemistry from the University of Chicago. He is currently a consultant for USDOE and USDOE laboratories. He has held membership in the Nuclear Regulatory Commission's Atomic Safety and Licensing Board Panel for the past 18 years. From 1953 to 1993, he worked as a chemist for Argonne National Laboratories, where he retired as the Director of the Chemical Technology Division. Dr. Steindler is also a member of the USNRC's Advisory Committee on Nuclear Waste where he was chairman from 1994–1995. Previously, he was a member of the waste–management subcommittee of the USNRC's Advisory Committee on Reactor Safeguards. He has authored over 130 papers and scientific reports, holds several patents, and has received many awards in his field.

THIBODEAUX, Louis J.—Dr. Thibodeaux is Jessie Coates Professor of Chemical Engineering at Louisiana State University. He served as Director of the Hazardous Substance Research Center South/Southwest until 1995 and was on the faculty of the University of Arkansas for sixteen years prior to returning to LSU where he received all three education degrees. In graduate school he held a National Council for Air and Stream Improvement fellowship. His teaching and research activities are concerned with the fate and transport of chemicals near environmental interfaces. Presently, his research focuses on contaminant release mechanisms from bed–sediments. In addition, he is a consultant for several organizations, government, private and academic, and has written a textbook.

TRAVIS, Curtis C.—Dr. Travis completed a Ph.D. in mathematics at the University of California, Davis, in 1971. He has been employed at Oak Ridge National Laboratory since 1976; currently, he is the Director of the Center for Risk Management in the Health Sciences Research Division. During his 10–year academic career, he served as a research engineer at the Jet Propulsion Laboratory at the California Institute of Technology and was assistant professor of mathematics at both Vanderbilt University and the University of Tennessee. Dr. Travis has served on several state and federal agencies' advisory groups and several National Research Council committees.

WARD, C. Herb—Dr. Ward has a B.S. from New Mexico State University and an M.S. and Ph.D. from Cornell University. He also earned an M.P.H. in environmental health from the University of Texas. Dr. Ward is the Foyt Family Chair of Engineering in the George R. Brown School of Engineering at Rice University. He is also Professor of Environmental Science and Engineering and Ecology and Evolutionary Biology. Dr. Ward is now Director of the Energy and Environmental Systems Institute (EESI) at Rice University. He is also the Director of the Department of Defense Advanced Applied Technology Demonstration Facility (AATDF). For the past 14 years he has directed the activities of the National Center for Ground–Water Research (NCGWR). He is co–director of the EPA–sponsored Hazardous Substances Research Center/South & Southwest (HSRC/ S&SW). Dr. Ward has served as president of both the American Institute of Biological Sciences and the Society of Industrial Microbiology, and is currently vice–president of the U.S. National Committee of the International Water Resources Association. He is the editor–in–chief of the international journal, *Environmental Toxicology and Chemistry.*

WATERS, Robert D.—Dr. Waters earned his B.S. in civil engineering from the University of Kentucky in 1983 and his Ph.D. in civil and environmental engineering from Vanderbilt University in 1993. He is a senior member of the technical staff at Sandia National Laboratories, primarily responsible for evaluating potential DOE sites for disposal of mixed low–level waste. He also has 7 years' experience in oil and gas production. Dr. Waters' research interests include technical and policy analysis for hazardous, radioactive, and mixed–waste disposal and assessment of environmental damage in the former Soviet Union. He is recipient of the NAS/NRC Collaboration in Basic Science and

Engineering (COBASE) and Collaborative Research in Sectoral Policy (CRSP) grants programs for research in the Ukraine.

WEBER, Walter J., Jr.—Dr. Weber completed a Ph.D. in environmental and water resources engineering at Harvard University in 1962. He is the Gordon M. Fair and Earnest Boyce Distinguished University Professor of Engineering in the Department of Civil and Environmental Engineering, the Director of the Great Lakes and Mid–Atlantic Hazardous Substance Research Center, and the Executive Director of the National Center for Integrated Bioremediation Research and Development Center at the University of Michigan in Ann Arbor. He has held various positions at the University of Michigan since 1963 and has served as a visiting professor both nationally and internationally. Since 1960, he has been a consultant to federal, state, and local governments, foreign, industry, and engineering firms. Dr. Weber's research focuses on phase separation technologies and process and transport modeling, ranging from fundamental concept development through the modeling and design of full–scale systems. He has authored or coauthored three books and approximately 300 technical publications. Dr. Weber is the recipient of numerous honors and awards and is a member of several national professional associations. He was elected to the NAE in 1985.

WENNERBERG, Linda—Dr. Wennerberg earned a Ph.D. in environmental law and resource economics from Michigan State University in 1984. Currently, she runs a private consulting practice applying 20 years' experience reviewing and developing environmental and economic policies with technical applications including a performance review of a federal toxic program; implementing radioactive and hazardous waste–management programs for state agencies; developing the draft–siting criteria process for low–level radioactive waste disposal; determining environmental enforcement priorities for oil and natural gas production; and identifying pollution prevention opportunities in manufacturing.

WYMER, Raymond G.—Dr. Wymer received his B.A. from Memphis State University and his M.A. and Ph.D. from Vanderbilt University. He retired as director of the Chemical Technology Division of Oak Ridge National Laboratory. He is a specialist in radiochemical separations technology for radioactive–waste management and nuclear fuel reprocessing. He is a consultant for ORNL and the USDOE in the area of chemical separations technology and for the U.S. Department of State and the USDOE on matters of nuclear nonproliferation. He is a fellow of the American Nuclear Society and the American Institute of Chemists and has received the American Institute of Chemical Engineers Robert E. Wilson Award in Nuclear Chemical Engineering and the American Nuclear Society's Special Award for Outstanding Work on the Nuclear Fuel Cycle.

APPENDIX D

ACRONYMS

AIBS	American Institute of Biological Sciences
APS	American Physical Society
ARAR	Applicable or Relevant and Appropriate Requirements
BEMR	*Baseline Environmental Management Report*
BES	Office of Basic Energy Sciences (DOE)
CEMT	Committee on Environmental Management Technologies
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	Decontamination and Decommissioning
DNAPL	Dense Nonaqueous Phase Liquids
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EM	Environmental Management
EO	Electrochemical Oxidation
ESP	Efficient Separations and Processing
FA	Focus Area
FASEB	Federation of American Societies for Experimental Biology

FFCA	Federal Facilities Compliance Act
FMS	Facility Mapping System
FY	Fiscal Year
GMODS	Glass Material Oxidation and Dissolution System
HER	Office of Health and Environmental Research (DOE)
HLW	High–Level Wastes
HWIR	Hazardous Waste Identification Rule
ICPP	Idaho Chemical Processing Plant
IDCS	Internal Duct Characterization System
INEL	Idaho National Engineering Laboratory
LDUA	Light Duty Utility Arm
LLW	Low–Level Wastes
LNAPL	Light Nonaqueous Phase Liquids
MACS	Mobile Automated Floor Characterization System
METC	Morgantown Energy Technology Center
MLLW	Mixed Low–Level Waste
MTRU	Mixed Transuranics
MWFA	Mixed Waste Focus Area
NAS	National Academy of Sciences
NASA	National Aeronautics and Space Administration
NDA	Non–Destructive Assay
NDE	Non–Destructive Evaluation
NIH	National Institutes of Health
NRC	National Research Council
NSF	National Science Foundation
OER	Office of Energy Research (DOE)
ORNL	Oak Ridge National Laboratory
OSHA	Office of Safety and Health Administration

OST	Office of Science and Technology (in DOE–EM)
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
RTDP	Robotics Technology Development Program
SARA	Superfund Amendments and Reauthorization Act (1986)
SCWO	Supercritical Water Oxidation
SERS	Selective Equipment Removal System
SPCS	Small Pipe Characterization System
STATS	Committee on Separations and Transmutation Systems (NRC)
STCG	Site Technology Coordination Group
STP	Site Treatment Plan
TCE	Trichlorethylene
TRU	Transuranic (wastes/elements)
TRUEX	Transuranic Extraction
USDOE	U.S. Department of Energy
USEPA	U.S. Environmental Protection Agency
USNRC	U.S. Nuclear Regulatory Commission
VETEM	Very Early Time Electromagnetic

Followup Questions and Answers

Mr. Peter N. Brush
Principal Deputy Assistant Secretary
Environment, Safety and Health
U.S. Department of Energy

Followup Questions and Answers

HEARING OF THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

on

The Department of Energy's FY 1997 Budget Requests for Environment, Safety and Health, Environmental Restoration and Waste Management (Non-Defense) and Nuclear Energy

Wednesday, May 1, 1996

Followup Questions Submitted to

Mr. Peter N. Brush
Principal Deputy Assistant Secretary for Environment, Safety and Health
U.S. Department of Energy

Q1. **What criteria do DOE use to decide whether a project should be funded by the non-defense portion of the Office of Environment, Safety and Health (ES&H) budget rather than out of the defense portion?**

A1. Funding for ES&H is provided in the Energy Supply Research and Development Appropriation (non-defense) and Other Defense Activities (defense). The budget structure of the Office of Environment, Safety and Health has changed for the FY 1997 budget cycle to reflect the major business lines identified in its strategic plan. Each account (defense/non-defense) has a Program Direction Decision Unit.

In the Other Defense Activities account, Oversight and Health Studies activities are funded. Historically, oversight of the Department's nuclear complex has been funded by the defense appropriation. In addition, most Health Studies activities, including Marshall Islands dose reconstruction functions, have been funded in the defense appropriation. The only health-related activity funded under the non-defense appropriation is the Radiation Effects Research Foundation of Japan, which has historically been funded under the Energy Supply Research and Development Appropriation.

Separation of these functions provides for avoidance of conflict of interest, as delineated in the Secretary's response to Section 3163 of the Fiscal Year 1995 National Defense Authorization Act. For example, the staff conducting oversight activities is independent of both line management and technical assistance efforts and is free of conflicts of interest that would compromise independence. Also, oversight in Other Defense Activities is not responsible for policy or technical assistance, while the non-defense activities encompass technical assistance and policy operations; this provides for clear separation of functions along appropriation accounts as well as business lines.

Q2. Sandia National Laboratories is a weapons lab with total FY 1996 ES&H funding of $282,000. Yet $217,000, or 77 percent, of this comes from the non-defense ES&H funds. Why is that?

Q3. Los Alamos National Laboratory is another weapons lab with total FY 1996 ES&H funding of $1.01 million. Yet $985,000, or 97.5 percent, of this comes from the non-defense ES&H funds. Why is that?

Q4. And finally, Lawrence Livermore National Laboratory is a weapons lab with total FY 1996 ES&H funding of $8.513 million. Yet $7.218 million, or 84.8 percent, of this comes from the non-defense ES&H funds. Why is that?

A2,3,4. This year the Environment, Safety and Health (ES&H) budget presentation is in a new format, divided into defense and non-defense sectors as much as possible. It is important to note however, that distinctions cannot always be made on a strict accounting basis. For example, in writing a new policy on radiation protection that applies to all activities in the Department, it would be impossible to tell how much expense is devoted to protecting workers at Los Alamos as opposed to how much is devoted to protecting workers at a non-defense laboratory such as Brookhaven National Laboratory.

A second point that speaks to the apparent anomaly in the amount of money being provided to defense labs from ES&H non-defense sources is that these funds are not being provided to the labs to be spent on their own programs. These funds are used to buy the services of the laboratories to conduct work throughout the Department of Energy complex. For example, if ES&H needs a plutonium criticality expert to help with work generically across the Department, we may buy these services from the Los Alamos National Laboratory, but the work will have benefits for the entire Department of Energy complex.

Q5. DOE's FY 1997 Congressional Budget Request's Program Object Summary for non-defense ESH on page 125 of Volume 2, states that, in FY 1996, $4.814 million of $85.649 million, or 5.7 percent was for "Advisory and assistance services" and that in FY 1997, $3.475 out of $73.16 million, or 4.7 percent will also be for "Advisory and assistance services."

What are these "Advisory and assistance services" and who provides them?

A5. Advisory and assistance services are acquired to provide objectivity and independence in the technical support area. Experts rendering technical advice are provided by management and operating contractors across the complex. These individuals are utilized on an as needed basis for their technical expertise and guidance.

An example of the type of expertise involved is that support provided by assisting EH in performing a study to determine that potential vulnerability of storing and handling highly enriched uranium at Department of Energy facilities.

Another example involves the services rendered by Pacific Northwest National Laboratory to provide support to EH in such areas as developing, maintaining, and implementing

Security Evaluations training and certification programs; extrapolating and defining analyses that can be performed with existing Security Evaluations data and, for each, to identify the data analysis requirements, the predicted results and benefits of analysis and the methodology for collecting data; providing new methodologies, tools, and technologies for use in inspections and in tracking emerging technology; and providing technical assistance, with topical area knowledge necessary to analyze and categorize current and forecasted threat postures based on the assessment of relevant information and accepted scenario methodologies and analyses.

Q6. DOE's FY 1997 Congressional Budget Request's Program Object Summary for non-defense ESH on page 125 of Volume 2, also states that, in FY 1996, 38.244 million of $85.649 million, or 44.7 percent was for "Other services" and that in FY 1997, $37.405 million out of $73.16 million, or 51.1 percent will also be for "Other services".

What are these "Other services" and who provides them?

A6. Other Services include financial assistance instruments such as grants and interagency agreements. These grants go to States, hospitals, colleges, the National Academy of Sciences, and other public institutions. They support projects such as epidemiological studies that determine the status of former workers and how that analytical material can be used to protect current and future workers. Interagency Agreements are with other Federal agencies such as the Departments of Commerce, Labor, Transportation, Health and Human Services, and Veterans Affairs the Environmental Protection Agency, the Nuclear Regulatory Commission, and National Institute of Standards and Technology. These agreements provide data for the Department in such areas as health studies and environmental protection. These agreements enable all the involved agencies to avoid duplication of efforts and data.

Q7. On page 7 of your prepared testimony, you indicated that your budget request for oversight also includes funds to continue to implement the Price Anderson Act Amendments of 1988 which gave the Department the authority to enforce nuclear safety rules and issue civil penalties on its contractors for violations of nuclear safety rules, and that you recently issued your first enforcement action in the form of a Notice of Violation against Pacific National Laboratories.

What was the violation and what was the penalty?

A7. The violation involved the contractor's failure to respond for over seven months to a tank's high level alarm as required by procedure and the current safety basis. As a result, an engineered safety feature for criticality prevention, the criticality safety slab tank, was unable to perform its designed function to prevent an inadvertent criticality. Subsequent evaluations by the contractor determined that the potential for criticality was low. However the contractor did not self-identify the noncompliance and the occurrence reflected a repetitive problem of extended duration.

Therefore, enforcement action was taken against Battelle Memorial Institute, operator of Pacific Northwest National Laboratory (PNNL) for violations of the Work Processes and Quality Improvement provisions of the Quality Assurance rule, 10 CFR 830.120. The action involved issuance of a Notice of Violation to which the contractor is required to respond within 30 days identifying corrective actions and the date when full compliance will be achieved.

DOE could not fine PNNL since Congress exempted Battelle statutorily in the Price Anderson Amendments Act of 1988 from receiving civil penalties for violations of nuclear safety requirements at PNNL. Since that time, DOE has issued additional enforcement actions including (1) a $37,500 civil penalty to Westinghouse Hanford Company for violations associated with an unplanned radiation exposure to a worker and (2) a $5,000 civil penalty to Sandia Corporation at Sandia National Laboratory for violations involving failure to central access to high radiation areas.

Q8. **On page 10 of your prepared testimony, you stated that in 1995, at the request of the Radiation Effects Research Foundation's Scientific Council, an international group of scientists was empaneled to independently assess the Foundation's current and future scientific activities, and that this Blue Ribbon Panel will issue its final report in June 1996.**

Q8a. What was the Panel's specific charge?

A8a. The Panel's specific charge was to conduct a thorough review of the Foundation's activities for the purpose of making recommendations on: the content, quality, importance, and merit of the current research program, what future research should be conducted, areas of research that could be conducted in collaboration with other institutions in Japan and worldwide, and the scientific peer review process.

The final report was presented on July 2, 1996, and recommends the continued support of core research programs centered in the Departments of Epidemiology, Statistics, and Information Technology, along with continued support of clinical services provided A-bomb survivors and studies of their children; provides concrete ideas for improving the scientific peer review process; promotes stronger collaboration between RERF and universities and organizations within Japan and worldwide; and recommends a strategic planning effort to improve the scientific management at RERF.

Q8b. Please provide a copy of the Panel's final report.

A8b. A copy has been provided. [*Note: Attached.*]

REPORT OF THE BLUE RIBBON PANEL

ブルーリボン委員会報告

REVIEW OF THE RADIATION EFFECTS RESEARCH FOUNDATION

PROFESSOR R H CLARKE
CHAIRMAN

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1. PREAMBLE

In April 1995 the Science Council of the Radiation Effects Research Foundation (RERF) issued a statement, considering it "appropriate and desirable that the scientific activities of RERF be assessed carefully and in depth by an outside expert group that has not been previously involved in RERF activities". The Council recommended that "a high-level international Committee of distinguished scientists be appointed to carry out an assessment of RERF's current and future scientific activities". The United States Department of Energy (DOE) and the Ministry of Health and Welfare of Japan (MHW) agreed to accept the recommendation to establish an international Blue Ribbon Panel and on 11 October 1995 they jointly appointed Professor Roger H. Clarke, Director of the United Kingdom National Radiological Protection Board, as its Chairman. [1.1]

The Panel was composed of scientists representing diverse disciplines related to radiation research and public health. Individuals with experience in medicine, epidemiology, radiation biology, immunology, health physics, biostatistics, genetics and public health were nominated. [1.2]

The Ministry of Health and Welfare and the Department of Energy nominated four members each; MHW nominated two Japanese and two third-country nationals while DOE nominated two US and two third-country nationals. The final composition of the Panel, shown at Annex I, was of a Chairman, two Japanese nationals, two US nationals, and four third-country nationals. [1.3]

[1.4] The Panel was charged with conducting a thorough review of RERF activities for the purpose of making recommendations regarding future research. Specifically the Panel was asked to focus on the following:

- the content and quality of the current research programme,
- what future research should be conducted,
- an evaluation of the importance and merit of research conducted at RERF,
- areas of research that could be conducted together with other institutions both in Japan and worldwide, and
- an assessment of the scientific peer review process.

In addition, guidance was given to the Panel that it should:

- identify areas to which RERF can contribute by providing other organisations in the world with its information and expertise or *vice versa*,
- identify how the RERF data can be used to advance world-wide radiation research while protecting the privacy of the survivors and other people cooperating in the research studies,
- consider how the health studies of aging survivors, second generation survivors, and survivors exposed to low-level radiation should proceed, and
- provide any additional suggestions and assessments, as needed.

[1.5] The original time schedule set for the panel by MHW and DOE was that it be appointed in October 1995, and would meet in March/April 1996 at Hiroshima and Nagasaki. Preliminary results would be presented to the Board of Directors meeting in May/June 1996 and the final report would be delivered to MHW, DOE and the Board of Directors by the end of July 1996.

[1.6] In the event the Panel held its first meeting at RERF in Hiroshima from 4-7 February and in Nagasaki 7-8 February 1996. On the first day the Panel heard of the early history of the Atomic Bomb Casualty Commission (ABCC), the precursor to RERF, and visited the Hiroshima Peace Museum, after which a commemorative wreath was laid at the Cenotaph.

[1.7] The Panel was welcomed to its formal session by the Chairman of RERF, Dr. Shigematsu. During the following days, presentations were made by the six Department Chiefs on their programmes in: Epidemiology, Statistics, Information Technology, Clinical Studies, Genetics and Radiobiology. Each presentation was followed by an informal session during which detailed discussions were held with a wide range of

Departmental staff so that the Panel could probe the depth of scientific and medical knowledge. [1.7]

The Panel also received a presentation from a representative of the US National Academy of Sciences on the management of its review and oversight programme at RERF. [1.8]

The Panel had the honour to meet Governor Fujita of Hiroshima Prefecture and heard of his tentative plans for the establishment of a Cancer Centre in Hiroshima which would have international links. [1.9]

At Nagasaki the presentations and discussions centred on the two Departments of Epidemiology and Clinical Studies, after which one of the co-chairmen of the Science Council presented a summary of the Council's views. [1.10]

The Panel held its second meeting at the Headquarters of the NRPB in the UK from 19-21 May 1996, during which time the content of the report was agreed upon. The report was finalised at the beginning of June 1996. [1.11]

2. OVERVIEW

The RERF research programme forms the most comprehensive study of a large, well-defined population that includes all ages and both sexes subjected to an instantaneous and wide range of radiation exposures. Several major research foci have evolved over time. These currently include epidemiological studies of cancer mortality and incidence and non-cancer mortality among the atomic-bomb survivors; ongoing clinical follow-up with the collection of biological specimens and longitudinal clinical measurements and data on morbidity in a fixed subset of the survivor population; genetic and epidemiological studies of the children of the survivors; and application of modern molecular, cytological, physiological and other technologies to the unique biological samples provided by the survivors in order to identify radiation-induced changes and to investigate the underlying biological mechanisms of these changes. [2.1]

Data on cancer mortality derived from the atomic-bomb survivors have become the primary source of cancer risk estimates. Other sources now largely provide substantiation of, rather than alternatives to, the atomic-bomb survivor-based assumptions. Worldwide, radiation protection standards for workers and the public are based on the survivor risk estimates, as promulgated in the 1990 recommendations of the International Commission on Radiological Protection. Risks associated with population exposures due to accidental radiation releases and individual exposures (for example, in probability of causation lawsuits) also are estimated based on atomic-bomb survivor data. RERF studies have shown that fetal radiation exposures affect physical and mental development and, as the *in utero* cohort ages, the nature of the excess [2.2] cancer risks in this group is being clarified. RERF is also the primary source of information on the occurrence and nature of genetic effects in humans following radiation exposure. [2.2]

Basic biological research at RERF already has clarified issues previously which cannot be resolved by physical dosimetric and epidemiological approaches. With recent and continuing worldwide advances in molecular genetics, RERF should be able to play a unique and central role in determining radiation's effects at the gene locus level. [2.3]

RERF is a unique research enterprise, studying an unparalleled population unlikely to exist again. At this juncture, there is an incomplete understanding of the late effects of radiation exposure during childhood and early adulthood while studies are just reaching a point at which important insights into the existence and nature of genetic effects can be gained. The follow-up of the Life Span Study (LSS) cohort of atomic-bomb survivors is the centre of the RERF epidemiology programme. The follow-up is based on the family registries which assure virtually complete ascertainment of death. *LSS Report 12* on cancer mortality among the LSS cohort from 1950 through 1990 emphasises how the excess cancer risks associated with radiation exposure depend on modifying factors such as sex, age-at-exposure, and attained age. [2.4]

The genetics programme at RERF is the singular study worldwide on the genetic effects of irradiation in humans. An important part of the genetic studies is the ongoing epidemiological follow-up of mortality and cancer incidence on over 80,000 first generation (F_1) offspring , about 43% being born to exposed parents and the rest to non-exposed parents. The follow-up has been based on both death certificate-based mortality and tumour registry-based cancer incidence. Epidemiology as well as studies on congenital defects, stillbirths, sex chromosome abnormalities and reciprocal translocations have not demonstrated a significant radiation-related increase in any endpoint. [2.5]

The Adult Health Study (AHS) operated by RERF and its predecessor, the Atomic Bomb Casualty Commission (ABCC), continues to be one of the largest and longest running clinical cohort studies in the world. During the 40 years of its existence, the AHS clinical programme has played a key role in obtaining and sustaining support for ABCC-RERF from the survivors and the local communities. The biennial AHS medical examination is the only part of the RERF programme that involves direct contact with survivors and thus serves as the main direct benefit that [2.6]

RERF provides to the survivors. It is RERF's primary source of information for understanding non-cancer effects of radiation, although information is also available from the mortality follow-up of the LSS. Through the AHS, biological materials are collected which will become increasingly useful for molecular and other bio-marker studies of cancer and non-cancer diseases. Again, it is stressed here that the effects of radiation exposure on diseases other than cancer remain largely unknown. The RERF clinical programme is an irreplaceable source of biochemical and physiological measurements that underpins all of RERF's epidemiological analyses, including those of non-cancer disease incidence.

3. THE POPULATION

[3.1] The health of over 200,000 people from Hiroshima and Nagasaki, covering both exposed and unexposed persons together with their offspring, has been under surveillance by RERF since the 1950s. Table 3.1 summarises the cohorts being followed and gives brief details about the way in which the subjects are being followed.

TABLE 3.1 - RERF COHORTS

NAME OF COHORT	NUMBER OF SUBJECTS
Life span study (LSS) *	120,300
Adult Health Study subset +	22,400
In utero exposure *	3,300
Adult Health Study subset +	1,100
Offspring of the survivors (F_1 generation)	88,500
TOTAL	212,100

* All subjects are followed routinely for death and, within Hiroshima and Nagasaki Prefectures, for cancer incidence. In addition, information on lifestyle factors such as smoking, alcohol consumption, diet and reproductive factors has been collected on the LSS cohort in four postal surveys conducted in, or around, 1960, 1970, 1980 and 1990.

+ Subjects in the Adult Health Study subset are routinely examined every two years and a vast amount of clinical data and biological specimens has been collected from these subjects.

[3.2] The Life Span Study population followed at RERF is unique for many reasons. Firstly, it includes large numbers of subjects with well-documented information about their exposure to ionising radiation. Secondly, for most subjects there is detailed information of high quality about personal characteristics (e.g. height and weight), and about habits (e.g. smoking, alcohol consumption and diet). For about 10% of the total population (i.e. the 22,000 people included in the Adult Health Study; see Table 3.1), clinical and biological characteristics are available. Thirdly, follow-up for cancer incidence and death has been continuing since the 1950s and very few subjects have been lost to follow-up. Finally, substantial numbers were exposed at young ages and, even though 50 years have elapsed since their exposure to radiation, the majority of these persons are still alive (see Table 3.2: among the approximately 86,000 persons with doses estimated under the DS86 Dosimetry System, about 31,000 of the 35,000 aged under 20 at the time of bombing were still alive in 1994). [3.2]

TABLE 3.2 - NUMBERS RECRUITED INTO THE LIFE SPAN STUDY IN 1950 AND NUMBERS STILL ALIVE IN 1994, BY AGE AT THE TIME OF THE BOMBING*

AGE AT THE TIME OF BOMBING	NUMBERS IN 1950	APPROXIMATE NUMBERS ALIVE IN 1994
0-9	17,824	16,500 (93%)
10-19	17,557	14,700 (84%)
20-29	10,882	7,700 (71%)
30-39	12,270	5,000 (41%)
40-49	13,489	1,000 (8%)
50 +	14,550	<100 (<1%)

*Restricted to persons with estimated DS86 dose.

Although other populations have been exposed to ionising radiation since the bombing of Hiroshima and Nagasaki, in no other situation has it been possible to set up detailed studies of large numbers of subjects of all ages and both sexes, who have substantial exposures to radiation with such reliable information both on radiation exposure and on subsequent health. Furthermore, this is one of the very few populations in which it is possible to study the effects of known exposures at early ages when more than 50 years have elapsed since the exposure. [3.3]

CONCLUSIONS

The population studies at RERF are unique not only because of the type of exposure received by such large numbers of subjects, but also because the quality of the information recorded about each individual is extremely high. It seems unlikely that a comparable opportunity to study the effects of ionising radiation on health in such a detailed way will present itself in the future: and even if it does, it will take 50 years to accrue as much information as now exists at RERF. [3.4]

4. REVIEW OF THE SCIENTIFIC PROGRAMME

General comments

In reviewing "the content and quality" of the Radiation Effects Research Foundation's scientific studies, the importance of this large group of research projects cannot be overestimated. Its importance lies in the uniqueness of the survivor cohort under study and in its central role in assessing radiation carcinogenesis and providing the basis for radiation protection standards throughout the world. It furnishes an as yet unfinished landmark study of radiation effects in humans that, it is hoped, will never be feasible again. The very nature of a large amount of the research done at RERF in epidemiology, in genetics, and in the Clinical Studies Programme requires that it is necessarily systematic and unchanging in character. [4.1]

The lifetime attributable cancer risk for radiation exposures in childhood is one of the most important unresolved problems of radiation protection of the population, and at present it is based on uncertain assumptions. Future observations at RERF are necessary to resolve this question. These observations will have to continue for several decades, when those who were exposed as infants will have reached the age of highest cancer rates. [4.2]

Risk estimates for radiation-induced cancer have in the past been based predominantly on the cancer *mortality* data and their analysis at RERF. The recent extensive work on cancer *incidence* has added a second and [4.3] equally important base for risk modelling and thus for the derivation of nominal risk factors. [4.3]

The scientific programme is reviewed in six topic areas, Epidemiology, Statistics, Information Technology, Clinical Studies, Genetics, and Radiobiology, in each of which work is undertaken at Hiroshima. The programmes at Nagasaki are in Epidemiology and Clinical Studies and are reviewed together with the work in those areas at Hiroshima. [4.4]

(I) EPIDEMIOLOGY

The main responsibilities of the two Departments of Epidemiology are: [4.5]

- the follow-up of the Life-Span Study (LSS), persons exposed *in utero* and F_1 (i.e. children of exposed subjects) cohorts for deaths and cancer registrations ;
- the maintenance of tumour and tissue registries in Hiroshima and Nagasaki;
- in-depth studies of the relation between radiation exposure and other lifestyle factors in the aetiology of disease.

Overall the Departments of Epidemiology are responsible for the follow-up of about 200,000 people. The largest group being followed are members of the Life-Span Study (LSS). So far about 8,000 cancers have occurred among the members of that population with DS86 doses; and about 20,000 tissue specimens are held from surgery and autopsies. Lifestyle information for most of the LSS population has been collected from four postal surveys carried out at about 10 yearly intervals, in approximately 1960, 1970, 1980 and 1990. [4.6]

Staff in the Departments of Epidemiology, working closely with staff in the Department of Statistics, have contributed to regular reports on deaths in the LSS population in relation to radiation exposure. As the mortality data have accumulated, these reports have evolved from a relatively straightforward presentation of tests for radiation effects to detailed analyses and characterisation of factors that affect the risk of death from cancer or other causes. The most recent report (*LSS Report 12*) addresses cancer mortality between 1950 and 1990. The excess [4.7] relative risk per unit dose has been estimated for 12 solid cancer sites [4.7] for which there were at least 100 deaths. For most of these cancer sites there has been a statistically significant increase in risk associated with radiation exposure. Furthermore, the data for many of the solid cancer sites are consistent with a common value for the excess relative risk.

The mortality data for all solid cancers combined show a remarkably linear [4.8] dose-response over the range 0-3 Sv, whereas for leukaemia the trend in risk with dose is non-linear with an upward curvature. While most of the excess leukaemia risk occurred in the first 15 years following exposure, the absolute excess rate for solid cancers increased during the follow-up in a manner that is roughly proportional to the increase in background rates with increasing age. The excess relative risk tends to be higher for exposure in childhood than in adulthood, and is higher for females than for males for most non-sex-specific cancer types. However, the age-specific excess absolute risks generally depend little on sex or age at exposure.

The earliest programme for monitoring cancer incidence in the atomic [4.9] bomb survivors grew out of efforts initiated in the late 1940s to register leukaemia and other haematological disorders. With the cooperation of medical associations in the locality, population-based tumour registries were established in 1957 in Hiroshima and 1958 in Nagasaki. These registries have been operated by staff at ABCC-RERF since their inception and are generally regarded as the best tumour registries in Japan. Data on cancer incidence in the LSS up to 1987 formed the basis of comprehensive reports published in 1994. These data represent an important complement to the cancer mortality data; despite the shorter follow-up period for solid cancer incidence, the number of cancer cases is greater than the number of deaths. Furthermore, the incidence data provide risk estimates for cancers with relatively low fatality, such as those of the breast, thyroid and skin, and clarify the examination of cancers for which death certificate information is often incomplete or inaccurate (eg. liver cancer). Work on cancer incidence in the LSS is continuing with a series of detailed site-specific studies.

The previous LSS follow-up indicated some association between non- [4.10] cancer mortality and radiation dose. This topic has been studied as part of the Adult Health Study (see section 4(iv)). In addition, a report based on the extended mortality follow-up is being prepared. Follow-up of those exposed *in utero* has indicated a possible increase related to radiation, although based on a small total number of cases. In contrast, no statistically significant trends with dose in mortality or cancer incidence have been observed in the F_1 cohort. As well as the continuation of these investigations, studies of familial aggregation of cancer in members of the LSS cohort are being planned. [4.10]

The cohorts being followed by the Departments of Epidemiology are among the largest and best documented in the world. Even if it were not for the unique exposure to ionising radiation of the population, the value of the information collected about lifestyle and health over such a long period of time is virtually unrivalled elsewhere. The epidemiology programme is central to the work of RERF. There is a great deal of interest in the effects of various aspects of Japanese lifestyle on health (especially dietary factors) and on the effects of the changes in lifestyle over the last 50 years. To make full use of the scientific data already held within RERF, a substantial additional epidemiological effort would be required. Collaboration with epidemiologists from within Japan and abroad, especially on exploring some of the aspects of the data that do not relate directly to radiation exposure, should be of great benefit to all concerned. [4.11]

CONCLUSIONS

The data held by the Departments of Epidemiology are of enormous importance, not only for assessing the effects of radiation on health, but also for determining the influence of various lifestyle factors on health and their interactions with radiation exposure. There is currently insufficient effort available to analyse the data and present reports, and much of the potentially valuable information collected has so far not been fully utilised. 4

RECOMMENDATION 1

We recommend that the Departments of Epidemiology should continue to collect data on mortality and cancer incidence, and that they be strengthened. The management of RERF should give these studies the highest priority in view of the size and scope of the data. In addition, research should be carried out by collaborating with epidemiologists from other institutions both in Japan and elsewhere, so that the full range of potentially valuable information already collected can be analysed.

(ii) STATISTICS

The Departments of Epidemiology and the Department of Statistics are [4.13] closely interlinked and jointly form the *central core* of RERF. Their tasks are specific and indispensable to the continuing follow-up of the A-bomb survivors and other aspects of the research programme.

The most recent studies of cancer amongst the survivors have provided [4.14] information that supports modified risk models, intermediate between the so-called absolute risk models and the relative risk models. The continuation of this work and the growing need to interlink analyses from the mortality and the incidence data will - beyond the obvious extension of the epidemiological efforts - require a broadened and stabilized team of scientists in the Department of Statistics.

Through its extensive body of work on the A-bomb survivors the [4.15] Statistics Department at RERF has had great influence on other radiation studies worldwide. Recently the Department began a very active cooperation with the radioepidemiological investigations on the highly exposed nuclear workers of Mayak in the Southern Urals and on the population of the villages on the contaminated Techa river in the former Soviet Union. These two studies deal with the health effects resulting from *continued exposures* and will, thus, be an essential complement of the studies on the atomic-bomb survivors who were subject to *exposure over a short time*. The new studies can largely be patterned on the work done on the A-bomb survivors, and this will give important feedback and added importance - but also added responsibilities - to the programme of RERF.

The Departmental staff in conjunction with collaborators have developed [4.16] the software package EPICURE which is currently used worldwide for the analysis of epidemiological data. It is important that the development of this software be continued because it facilitates comparability between different studies.

The work on cancer mortality and incidence has been the subject of [4.17] extensive publications, and for a number of years now - in a significant departure from earlier policies - well-documented basic data sets have been made available for analysis by other groups. For work on malformations due to prenatal exposure - and specifically the important observations on mental retardation and the reduction of IQ - similar progress has not yet been achieved. Important analyses have been performed, but the statistical treatment has been less systematic, and publications are less complete. The basic data sets - for example on the results of intelligence tests and other studies on the prenatally exposed - have not yet been made available outside RERF. [4.17]

CONCLUSIONS

[4.18] Highly successful work has been performed in the Department of Statistics, which is a source of great strength for the entire organisation. Its input has been essential in making the accumulated data sets the worldwide basis for the estimation of human radiation risks.

RECOMMENDATION 2

We recommend that the Department of Statistics should continue to produce analyses of the risks of radiation exposure in collaboration with the Epidemiology Departments and that the high quality of the research in the Statistics Department be maintained.

RECOMMENDATION 3

We recommend that the Department of Statistics should continue to make available basic data sets on mortality and cancer incidence for analysis by other groups. This should now be extended to making available those data sets relating to mental retardation, IQ, and related outcomes of exposure *in utero*.

(iii) INFORMATION TECHNOLOGY

[4.19] The Panel received an informative presentation from the Information Technology Department, in which it learned that for most of RERF's lifetime, data associated with the separate research programmes have been maintained on a series of mainframes and often analysed using specialised software, which has had to be developed within the organisation.

[4.20] It was recognised by the late 1980s that the increasing power and decreasing costs of PCs and RISC based workstations, together with the availability of much general software for inter-computer communications, database management, data analysis and graphics pointed to a move from mainframe computing to a distributed network. A major programme was therefore begun in 1991 to install an integrated system of networked IBM-compatible PCs and Unix workstations, and at the end of 1994 the previous mainframe was removed.

[4.21] This change in direction has brought many advantages to RERF. Internal communications within RERF - including communications between Nagasaki and Hiroshima - are much improved, access to Internet and its facilities are available and RERF can now use readily available commercial software packages for business management. In addition, the individual PCs can readily manage much of the statistical analysis, data handling and graphics associated with particular projects on a stand-alone basis.

[4.22] In practice, it has turned out that the move to a distributed network has led to significant economies and the present system, which is overall more powerful than its predecessor, has been less expensive, both to install and to maintain.

[4.23] Perhaps the most important innovation has been the installation of a new relational database in the Unix environment, and the transfer to it of the major data files such as the Master File, the tumour registry, tissue registries, the LSS and the DS86 dosimetry. Apart from eliminating many redundancies, this amalgamation of data from overlapping research programmes greatly facilitates the capture into working files of all available information on cohort members for subsequent analysis and study.

[4.24] There is still much to be done to include further data still held in independent files, so that all relevant data on individuals can be assembled efficiently, and we understand that further incorporations are in train. At the same time, the discipline of operating within a single coherent database system is seen to be helpful in that it requires close and careful scrutiny of the various data sources in order that they may be included in a systematic way. At the end of the day, this coordination of all of RERF's major data holdings within the one system should lead to a richer and more robust body of data for the cohort studies in general. [4.24]

From the perspective of research outcomes, the Panel believes that the changes to the computing environment will enhance the quality of the studies and open up ways in which any new directions may be followed in an efficient manner.

The Information Technology Department, in its presentation to the Panel, acknowledged that there are still many things to be completed in support of RERF's research and appears to have a clear sense of direction in its future planning. Its members also pointed out that the introduction of a new and unfamiliar system has required them to enhance their user support and to provide training and assistance when users encounter difficulties.

CONCLUSIONS

Efficient data management and computing are the backbones to the success of research at RERF. The Panel believes that RERF has taken the right strategic decisions with respect to computing infrastructure, and the Department has gone about implementing them with considerable skill and intelligence. Impressive progress has been made over the last few years in creating a central linked database.

RECOMMENDATION 4

We recommend that strong support continue to be given to the Department of Information Technology because it is essential that the large body of data collected over many decades is properly stored, documented and accessible to researchers at RERF.

(iv) CLINICAL STUDIES

The Clinical Studies Research Programme is based largely on the Adult Health Study (AHS), the cohort of about 20,000 out of the Life Span Study (LSS) of 120,000. Since 1978, about 2400 Life Span Study participants and 1000 *in utero* exposed persons have been added to this sample. Every other year, all participants are examined in detail, including history, physical examinations, ECG, chest x ray, ultrasonography, blood tests, etc. Other data, such as information on lifestyle and results of special tests including bone density and gynaecologic examinations, are also collected. [4.28]

The necessarily repetitive nature of many of the research projects was apparent in the presentations to the Panel. Many of the current projects are very much like those of yesterday; some essentially provide further documentation of prior findings. Yet this kind of organised, iterative, systematic, and meticulous study and clinical follow up is essential to fulfil the goal of providing a precise database for determining cancer risk estimates and for exploring non-cancer diseases associated with radiation exposure. Like the Life Span Study, the Adult Health Study derives its importance from the unique value of the survivor cohort. [4.29]

An important function of the Clinical Studies Programme is to bind the exposed populations in Hiroshima and Nagasaki to the Radiation Effects Research Foundation and its scientific programme. The AHS is literally the only systematic link of RERF with survivors; it provides them with a visible service, one which they obviously value, as indicated by the high level of voluntary participation. The biennial medical examinations of the AHS cohort also provide elements of medical social work - support, attention and respect - without which it seems doubtful that the full cooperation of the surviving populace of the two cities could be attained. The AHS should be considered as one of the important measures directly beneficial to the health of the survivors. [4.30]

The contributions of the AHS may be described in three broad categories: [4.31]

☐ studies that augment, enrich or supplement the findings of the Life Span Study by supplying additional clinical and laboratory data on cancer and on potential contributing factors and/or confounders in the aetiology of disease;

☐ studies that focus on issues other than the central focus of the Life Span Study: in particular, the detection and analysis of the effects of radiation that cannot be studied through mortality or cancer incidence data; and [4.31]

- the provision of biological materials essential to other investigations at RERF.

[4.32] A major function of the clinical programme is the early detection of carcinoma in the AHS. Furthermore, a unique contribution of the AHS lies in its exploration of the possible associations between radiation exposure and diseases other than cancer. The non-cancer AHS studies may be grouped into three categories: those in which significant radiation-related effects have been established; those in which suggestive (but not definitively established) radiation-related effects have been noted; and those in which no radiation-related effects have been found.

[4.33] Significant radiation-related effects to those exposed *in utero* were manifest in small head size and mental deficiency. In addition, brain damage has been found in severely mentally retarded individuals examined later in life and exposed *in utero* between the eighth and fifteenth week of gestation. A significant and dose-related increase in the incidence of uterine myomas has been found among the survivors, as well as a significant and dose-related increase in the incidence of parathyroid adenomas. Lenticular opacities, which are well-known to be radiation-induced, were found in increased incidence in this population in studies conducted twenty years ago. An update is planned. It is desirable - and also urgent in the view of the aging of the survivor cohort - to conduct more sophisticated cataract studies.

[4.34] Suggestive radiation-related increases in cardiovascular disease incidence, specifically the incidence of myocardial infarction, cerebral infarction, and the prevalence of aortic arch calcification and systolic hypertension require further studies to confirm a real association between radiation exposure and atherosclerosis. Similarly, suggestive increases in the incidence of thyroid adenomas and chronic liver disease in the exposed population have been noted in AHS studies, although the latter finding may reflect a high level of hepatitis virus infection. In another study, the onset of menopause has been found to occur earlier among the heavily exposed survivors than among the unexposed; analysis of serum FSH and oestrogen levels in the remaining premenopausal women is under way.

[4.35] No increases have been found in mortality or incidence of congenital abnormalities in the F_1 progeny, although no systematic clinical examinations have occurred since the first year of life in this group. Both dominant disorders and multifactorial inherited diseases frequently are manifest after the first decade of life and, in the latter case, usually after adulthood. Further study of this cohort is essential; while under the Genetics Department, it would require the direct participation of the Clinical Studies Programme. Studies of thoracic vertebral fracture have shown no correlation with radiation exposure. Studies of senile dementia are under way, as is an evaluation of physiological measurements in more than 8,000 AHS participants as a predictor of mortality or morbidity associated with aging. Accelerated aging has not been demonstrated.

[4.36] The Clinical Studies Programme maintains a collection of 110,000 frozen serum samples and 11,000 plasma samples spanning the last thirty years of the programme; in addition, there are 13,000 lymphocyte samples for the Department of Radiobiology, which maintains its collection in liquid nitrogen. These and other samples will make possible the retrospective determination of potential confounding factors and contribute to special studies of the immune system. Further, the Clinical Studies Programme has been involved in obtaining the cell lines from 800 families - 1600 parents and 1200 children - for a major project to screen DNA samples from parent-child trios. This is the largest fixed cohort population in the world for the detection of radiation effects on human germ line mutations. Finally, the Clinical Studies Programme is involved in providing the teeth essential for dosimetry studies based on electron-spin resonance of tooth enamel.

CONCLUSIONS

[4.37] The importance and merit of the research lies largely in the size and quality of follow-up of the LSS and AHS populations, the quality of the epidemiology and statistics as they relate to the LSS and AHS groups, and the continuing assessment of *in utero* exposed survivors. The role of the Departments of Clinical Studies is central to attaining many of the goals of all divisions.

[4.38] The content and quality of the research lies in the collaborative role that the Departments play with all other Departments:

☐ by providing clinical data on fatal and non-fatal carcinomas and on non-cancer effects of radiation exposure;

- by enabling in-depth investigations of associations to be observed in the LSS; [4.38]

- by furnishing a unique pool of serum, plasma and lymphocyte samples; and

- by providing an essential "bridge" function to the survivors.

RECOMMENDATION 5

We recommend that while many of the Clinical Studies projects under way should be extended, the programme should be critically reviewed so that those which are not promising are discontinued. The continuing surveillance of the cohort who were children in 1945 and are now adults is likely to be revealing, since radiation sensitivity may be highest in the young.

RECOMMENDATION 6

We recognise that the AHS is vital to the wellbeing of the survivors and we recommend that this important service continue, since we believe it has led to their high level of cooperation with RERF. As the population ages and health problems become more complex, consideration needs to be given to ensuring that the voluntary participation remains high.

(v) GENETICS

[4.39] The Genetics Department aims its work at two major issues. The first and traditional task has been the assessment of hereditary damage in the offspring of the A-bomb survivors. A second task is the work in cytogenetics and more recently in other biological dosimetry, in order to reconstruct doses and/or to assess the validity of the DS86 dosimetry system.

The offspring of those exposed

[4.40] Extensive studies of untoward pregnancy outcomes, mortality exclusive of cancer, malignant tumours in the first two decades of life, cytogenetics, and protein biochemical genetics in the children (F_1 generation) of the A-bomb survivors have shown no evidence of excess. This led to the initial conclusion that human sensitivity to these effects appears to be substantially less than those derived in early studies on mice. Recently the mouse data were critically reassessed, and it is now uncertain whether humans are, in fact, substantially less sensitive than the mouse to the mutagenic effects of ionising radiations.

[4.41] As a consequence of unresolved judgements on the animal data, it is uncertain whether risk estimates for radiation-induced hereditary damage can be based on animal studies. For this and other reasons, full use must be made of the potential insights that can be obtained from the observations in families of A-bomb survivors. Recent work in the Genetics Department is focusing on studies in molecular biology that utilize immortalized B-lymphocyte cell lines, to discover differences in mutation rates between 500 families with exposed parent(s) and an equal number of control families without exposures. Innovative new techniques (e.g. the examination of mutations at mini-satellite loci) have been employed on a pilot basis in these studies but have not, up to now, demonstrated enhanced mutation rates in the exposed genomes. All of these studies are based on rapidly evolving techniques of molecular biology and thus must be considered as initial efforts. Future developments in molecular biology should permit far more complete analyses. They might ultimately allow the precise assessment to be made of molecular changes in the genome of family members.

The exposed population

[4.42] Cytogenetic studies have long been an important part of the work of RERF and its predecessor organization. In earlier times, they were restricted to the determination of unsymmetric chromosome aberrations - such as dicentrics. As these aberrations are 'unstable', i.e. incompatible with cell proliferation, they have only limited persistence of, typically, a [4.42] few years. Although important questions were still unresolved - especially the apparently different dose dependencies in Hiroshima and in Nagasaki - it has become, therefore, less attractive in the recent past to invest work in these studies.

The advances of molecular biology have changed the situation and have [4.43] given new momentum to the work in biological dosimetry with chromosomes through the technique of FISH (*f*luorescence *i*n *s*itu *h*ybridization). This work has made it possible, by now, to determine symmetric, i.e. stable, chromosome aberrations, without excessive investment of manpower. This Department has taken effective leadership in the development and practical use of the FISH technique which allows retrospective biological dosimetry for exposures that occurred many years ago.

The Genetics Department has also taken the initiative to make the FISH [4.44] technique available to Russian scientists working at Mayak and at the Techa river. Together with the involvement of European groups, this has led to an international network of cooperation for the intercomparison and improvement of cytogenetic methods. In view of various aspects of the FISH technique that are still unresolved, it is essential that the current intercomparisons and the joint application of the new methods to various exposed populations be continued and even extended. This relates to the A-bomb survivors, the nuclear workers at Mayak, the Techa river populations, the populations subjected to fallout from the Semipalatinsk nuclear tests, and certain groups that have been exposed after the Chernobyl accident.

This Department has put into practice improved techniques of ESR [4.45] (electron spin resonance) dosimetry, specifically on teeth. This approach complements the cytogenetics results and it is, therefore, justified that the ESR dosimetry studies be given equal priority. While it is essential that the best techniques be used, there is no requirement for separate methodological work in the group; it is, therefore, appropriate that the Department has established external links to share new technical developments, especially the use of dentin in addition to the tooth enamel.

Parallel applications of the two techniques, FISH dosimetry and ESR [4.46] dosimetry, to A-bomb survivors and other exposed groups have shown that the chromosome studies will gain greatly from the intercomparison of the results. The tooth dosimetry studies will be restricted to fewer

[4.46] cases, but they appear to be applicable to lower doses and are subject to less variability; they can, therefore, serve as an added 'calibration' that sharpens the results of the chromosome studies.

CONCLUSIONS

[4.47] While molecular biology investigations will enable the most detailed determinations to be undertaken and will thus be the focus of future work, there is nevertheless need to continue - and even to extend - the more conventional studies of the health of the offspring (F_1 generation). They will also have continued importance because it remains uncertain at what point molecular studies can come sufficiently close to the resolution of the problem of multifactorial hereditary damage produced by radiation.

[4.48] It does now appear that there can be a more complete chain linking the evolving physics dosimetry and individual data on location at the time of the bombing to chromosome data, to tooth data, and data from solid state dosimetry on other objects, such as building materials, ceramics, or jewellery. While dosimetry has traditionally not been the task of RERF, these new interconnections will be very important for validating the DS86 dosimetry system.

RECOMMENDATION 7

We recommend that the studies on the health of the offspring (F_1 generation) of the survivors continue, since they may elucidate data on multifactorial disease while also providing direct benefit to the survivors and their offspring.

RECOMMENDATION 8

We recommend the preservation of biological samples for FISH analysis and for ESR, together with the documentation that will be needed to compare dose estimates based on biological samples with those from physics assessments.

RECOMMENDATION 9

We recommend the continuation of the storage of biological materials and associated documentation for future molecular genetic studies.

RECOMMENDATION 10

We recommend that the most advanced methods and expertise in cytogenetics continue to be available at RERF.

(vi) RADIOBIOLOGY

The Department of Radiobiology is a comparatively recent branch of RERF. It has been established to ensure that full use is made of the singular biological material available to RERF, especially the potential for performing molecular biology studies of familial relations in A-bomb survivors, their children and grandchildren. Work is being performed on molecular oncology, on immunology and on somatic mutations. The latter is to, some degree, interlinked with the efforts of the cytogenetics group on biological dosimetry. The studies on molecular oncology and immunology are closely related, because they are primarily directed towards the elucidation of the molecular and cellular steps in the process of carcinogenesis.

Molecular oncology

One of the most significant developments in radiobiology and generally in radiation research is the emergence of what may be called *molecular epidemiology*. It is still uncertain whether there are molecular markers, i.e. gene alterations, that are specific to - or that tend to be correlated with - certain causative factors, such as ionizing radiation. Molecular biology studies with this aim are now conducted in many laboratories worldwide. If specific markers can be found, radiation epidemiology will have an entirely new basis. Obviously this would be of central importance to the core programme of RERF. The archives of tumour and normal tissue material from A-bomb survivors are of greatest importance in view of these developments, and the extension and up-keep of the repositories is a central task for RERF. It is also essential that full expertise be available at RERF for adequate planning and for utilization of any methods that may become practicable. The radiobiology programme has met this challenge successfully. It is particularly important that it has been examining the methods to utilize archival material from autopsies more than 40 years old and that it has, in fact, demonstrated that gene amplification works as well with this material as with fresh probes. A variety of known oncogenes and tumour suppressor genes has been examined in current studies, which attests to the expertise of the research group. [4 50

Immunology

Better insight into the function of the lymphocyte system will be a precondition for untangling the mechanisms of carcinogenesis. Important questions are still unsolved and it is therefore appropriate that RERF utilizes its specific wealth of information to contribute to the required investigations. The particular strengths of the studies at RERF are the repeated observations in groups of A-bomb survivors that extend over sufficiently long periods to demonstrate the effects of aging, and the combined effect of aging and radiation exposure on the immune competence of T-cells. Very little is still known about the clonal expansions that originate from individual normal and stem cells. Recent studies at RERF on clonal expansion are, therefore, of special interest; these studies show that one and the same chromosomal aberration can appear in substantial fractions of T-cells, B-cells, erythroid progenitor cells and myeloid progenitors. Such studies may become the singular basis of much improved quantitative knowledge of the kinetics of the haematopoietic system. They can be the focus of important international cooperation using the observational material available only at RERF. [4.51]

Somatic mutations

Somatic mutations at three different gene loci, HLA, TCR, and HPRT, are being studied as possible instruments of an alternative form of biological dosimetry. It appears that these systems are applicable when exposures are recent, while the mutations are not sufficiently persistent to provide reliable information on exposures that occurred a number of years ago or in the more distant past. There are indications in some of the studies on the A-bomb survivors that determination of the erythrocyte glycophorin A mutation (GPA) is more promising as a method to determine past exposures. But, as a whole, it would appear that FISH in lymphocytes and, in particular, ESR in teeth are superior approaches for biological dosimetry. The study of somatic mutations may still be justified in view of possible but still unknown future advances, but it does not appear to have special priority at this point. [4.52]

CONCLUSIONS

The archives of tumour and normal tissue material for molecular and biological studies from A-bomb survivors are of great importance in view of developments in molecular biology, and the extension and upkeep of the repositories is a central task for RERF. [4.53]

The particular strengths of the immunology studies at RERF are the repeated observations in groups of A-bomb survivors that extend over sufficiently long periods to demonstrate the effects of aging, and the combined effect of aging and radiation exposure on the immune competence of T-cells. Recent studies on clonal expansion are of special interest. [4.54]

Somatic mutation systems are applicable for biological dosimetry when exposures are recent, but the mutations are not sufficiently persistent to provide reliable information on exposures that occurred in the distant past.

The establishment of causality in epidemiological studies requires several conditions in addition to a strong association. Among these conditions the postulation of a "plausible mechanism" is essential. This postulation, in the form of a mechanistic model, is also the basis for extrapolations beyond the observations, particularly at very low values of the cause.

It is clear, therefore, that RERF radiation risk studies will always be related, explicitly or implicitly, to mechanisms and models. The spectacular increase in the understanding of the cancer process on the basis of molecular genetics indicates that models will evolve in this direction. While it does not seem appropriate to specifically include modellers in the staff of RERF, it would be very important that the implications of data from experimental studies are kept under review as they may influence the research strategy of the Foundation.

RECOMMENDATION 11

We recommend that the Department of Radiobiology should focus on molecular epidemiology and immunology and that strong links should be forged between RERF and the relevant groups around the world involved in modelling the carcinogenic process.

5. FUTURE ACTIVITIES

LSS Report 12 highlights the uncertainties associated with the current internationally recommended estimates of radiation induced cancer risk, especially for those exposed as children. The evidence to date suggests that solid cancer excess risks are likely to persist and that excess rates will increase throughout life. Excess relative risks for solid cancers among those exposed as adults have remained fairly constant throughout their lifetimes. For people exposed in childhood, there is some evidence that relative risks have declined slightly; however, excess rates (ie absolute risks) for this group are increasing with age in a manner consistent with the increases seen for those exposed as adults. For those exposed as children, the total number of cancer deaths is currently small; however, this number is doubling every 5 years, and estimates of the number of excess cases are increasing at about the same rate. [5.1]

Although lifetime follow-up is essentially complete for those exposed when older than age 50, more than half of the LSS cohort and over 90% of those exposed as children are alive now. Table 5.1 gives both the actual and projected numbers of persons in the cohort. By the year 2000, the number of cancer deaths among those exposed when younger than age 20 will be 3 to 4 times that seen up to 1990 and will continue to increase rapidly throughout the first 10 to 15 years of the next century. Therefore continued follow-up of those exposed as children or as young adults is essential to the understanding of radiation-induced cancer risks in this cohort. [5.2]

TABLE 5.1 LSS COHORT* SIZE, 1950-2020

	YEAR 1950	1990	1995	2000	2005	2010	2015	2020
AGE AT EXPOSURE (y)								
0-9	17,824	16,768	16,450	15,990	15,290	14,280	12,710	10,390
10-19	17,557	15,163	14,500	13,540	12,040	9,800	6,780	3,620
≥ 20	51,191	16,971	12,800	8,910	5,430	2,710	970	100
Total	86,572	48,902	43,750	38,440	32,760	26,790	20,460	14,110
AVERAGE ATTAINED AGE								
(y)	33.5	61.4	64.7	67.9	71.3	74.7	78.0	81.3
AVERAGE AGE AT ATB								
(y)	28.5	16.4	14.7	12.9	11.3	9.7	8.0	6.3

* Restricted to persons with known DS86 dose

Note: ATB = at the time of the bombing

Continued follow-up together with advances in analytical methods are making it possible to address more complex issues than in the past. RERF researchers are developing alternatives to the time-constant (given sex and age at exposure) relative risk models that play a central role in current descriptions of radiation effects on solid cancer risks. These alternative models help to quantify uncertainties in current risk estimates, especially for those exposed as children, and may provide useful insights into the nature of radiation carcinogenesis. [5.3]

Current data suggest that leukaemia risks for those exposed as adults have persisted throughout life, whereas excess risks for those exposed as children have decreased with time. In view of the complex pattern of excess leukaemia risks following radiation exposure, continued assessment is necessary for complete understanding. Additional follow-up is also necessary to clarify the nature of excess risks for myeloma and lymphoma. [5.4]

The first comprehensive analysis of the LSS cancer incidence data was published in 1994. These data represent an important complement to the cancer mortality data. Despite the shorter follow-up period for solid cancer incidence (since the tumour registries did not start operation until 1958), the number of cancer cases is greater than the number of deaths. The incidence data provide risk estimates for cancers with lower fatality rates, such as breast, thyroid and skin, than most other cancers and help to clarify the situation for cancers like liver cancer for which death certificate information is often incomplete or inaccurate. A priority is the development of procedures that will allow the unification of the incidence [5.5] and mortality data. The tumour registry incidence data already are being used as the basis for a number of site-specific incidence studies, and increased use of data on cancer incidence in the LSS should be used as the basis for case-control studies. [5.5]

As evidenced by the attention focused on the Sellafield (UK) leukaemia cluster, issues related to the heritable effects of radiation exposure are of great public and scientific concern. The RERF first-generation (F_1) cohort of children of the atomic-bomb survivors is the most powerful epidemiological study able to address whether excess cancer or non-cancer risks result from parental exposures. To date, no evidence of excess risks exists. However, cohort members are relatively young (with an average age of 39 in 1995), so several more decades of follow-up will be necessary to obtain a reasonable assessment of cancer risks (or the lack thereof) in this population. There is increased attention being devoted to this issue by international radiation protection programmes, and the RERF prospective study will provide hard data independent of theoretical considerations. [5.6]

The value of AHS is in studying the modifying effects of other factors, as well as looking at non-radiation effects generally. The most important epidemiological role of the AHS programme is monitoring of non-cancer diseases that will subsequently result in mortality, such as atherosclerotic diseases and chronic liver diseases, the incidence of which seems to be increased by radiation exposure. New approaches to study these diseases are being introduced. [5.7]

With a collection of 110,000 frozen samples of serum, it is possible to go back in time to determine if specific confounders, such as homocysteine levels (recently implicated in coronary disease), hepatitis C or other infections may have influenced the course of the above mentioned diseases. The clinical programme also serves as the source of cell collection for the genetics, cytogenetics, and radiobiology studies and more recently for the collection of teeth for the ESR dosimetry analysis. [5.8]

While results to date show that the human genome is not unusually sensitive to irradiation and indeed may be less sensitive than that of the laboratory mouse, further studies are needed to resolve the issue. No systematic clinical examinations of the offspring (F_1) have occurred since their first year of life. The majority of both dominant disorders and multifactorial inherited diseases are manifest after the first decade of life and, in the latter case, usually after adulthood. A feasibility study in this [5 9] area would be of considerable benefit. Based on the very high participation rate, 75-80%, of the children of the survivors during the period 1976-84, when the cytogenetics and protein studies were undertaken, an enthusiastic response from them may be expected. There is an indication that the offspring are anxious about possible health effects since media reports on other radiation-related studies arouse concerns. [5.9]

A well-designed clinical study of the F_1 cohort using currently available screening methods to identify better defined sentinel phenotypes could provide useful information about genetically based detriment to health and there should be consideration of the feasibility of such a study. This may best be done by convening a workshop on the topic. We believe that during the next two decades, it will become clear whether subsequent generations (F_2) need to be studied, so that at present we do not recommend their study. [5.10]

Molecular studies in genetics should determine whether mutations were transmitted to the progeny at a variety of genetic sites and what the molecular changes are. The cytogenetic study of parent lymphocytes is recommended to substantiate the theoretical DS86 doses. [5.11]

The work on radiobiology should concentrate on the analytical studies of the changes at the molecular level involved in tumour development. There is rapid advancement around the world in molecular biology and these developments should be used to focus on the mechanisms of radiation-induced oncogenesis so as to better quantify the risks of low doses of radiation. [5.12]

RECOMMENDATION 12

We recommend that the LSS research programme should continue until the survivor cohort has died, so as to provide an authentic and complete assessment of the neoplastic and non-neoplastic effects of radiation. We also recognise that there are both medical and social aspects of the AHS that are of direct benefit to the promotion of the health of the A-bomb survivors and their offspring.

RECOMMENDATION 13

We recommend consideration be given to further investigation into the health of the offspring (F_1 cohort) since it may well yield valuable information on genetic effects, especially when conducted together with research using the new molecular genetics techniques.

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We recommend that the recently initiated work on the molecular mechanisms of carcinogenesis should be focussed to elicit the shape of the dose-response curve at low doses of radiation.

RECOMMENDATION 15

RERF has a valuable source of surgical and autopsy specimens and of serum, plasma and lymphocyte samples and we recommend that an explicit policy be developed over the management and ethics of the provision of biological samples for use in research, especially outside RERF.

6. STRATEGIC PLANNING AND PROGRAMME MANAGEMENT

While the work of the various scientific departments within RERF has generally been effective and in some areas particularly impressive, there are signs that progress has recently been hampered by severe pressure on professional resources, a situation which we understand is likely to prevail to some extent in future. It is very important therefore that attention is given by the RERF management to the development of long term forward planning processes to achieve the best outcomes within the available budget. [6.1]

The overall goals and objectives presented to the Panel and the research strategies adopted to reach these goals correctly reflect well RERF's charter. They have evolved over time, drawing on the recommendations of successive reviews and on the outcomes of a series of *ad hoc* workshops in particular fields. The Board of Directors is to be commended for the initiatives it has taken in the past to ensure that the organisation's research strategies are kept up to date with advances in the relevant sciences. In the present times, however, it is normal to take forward planning much further and for management to identify more clearly their programmes, the sub-programmes and projects which fit within them, their relative priorities and the resource obligations which go with them. [6.2]

Planning can take many forms, but its essential ingredient is to provide a stable framework over (say) a five year time span, against which corporate decisions regarding priorities and resource allocations can be [6.3] made, which best reflect RERF's goals. A strategic plan should be forward looking and flexible enough to take into account changes as projects within each Department develop and reach defined milestones or point towards sensible changes in direction. One of its important functions should be to establish for each of the Departments a stable level of core funding, so that programme managers can confidently plan over a five year horizon. We would expect that each passing year would see the updating of a five year "rolling" strategic plan, which accommodates to progress over time, and introduces new aspects as they become relevant. [6.3]

Perhaps a good illustrative example of the need for global setting of priorities is the assessment of the role and the provision of adequate resources for the Department of Statistics. The Panel was advised that this Department provides expert guidance throughout the organisation, especially to the Departments of Epidemiology and the Department of Information Technology, and in addition has the further responsibility for the understanding and interpretation of the DS86 dosimetry. During the recent period of financial stringency, this Department has endured at least the same degree of attrition and financial constraint as the other Departments, yet deficiencies in this area may have a disproportionate impact on the productivity of the entire organisation. RERF will need to examine its role carefully, since issues such as this can only be addressed by the senior management. [6.4]

Programme management requires a certain amount of formality to ensure the regular tracking of projects against planning targets and agreed milestones as well as the airing of proposals for new or modified projects. An integral part of this is the periodic external assessment of all sub-programmes and projects. The Panel was advised that the present processes for external scrutiny, carried out by the RERF Science Council, are limited and insufficient for detailed assessment and guidance. [6.5]

At the Departmental level, there would be a need to review annually with the Chief of Research the progress of individual projects against agreed milestones, to make adjustments where necessary, to set further milestones where appropriate and to foreshadow new directions which projects and the programme may follow. [6.6]

An additional mechanism, which has been found to work well, is the formation of an internal review panel, involving senior staff from all of the Departments (including Department chiefs) who, over time, review [6.7] projects in each Department against agreed milestones and report their assessments to the Chief of Research. Such a process is helpful also in maintaining an informed understanding amongst the staff of the work of their colleagues in other Departments and a better appreciation of the way in which their own work fits within the broader goals of RERF. [6.7]

CONCLUSIONS

Programme management in a research environment such as RERF requires a deftness of touch to ensure that the processes are not so formalised and heavy handed that they obstruct the development of new ideas. Nevertheless, it has been the experience in other establishments that overall strategic planning and a firm commitment to fairly detailed programme management is needed to secure the best outcomes in the present (worldwide) climate of constrained resources. In practical terms, the plan will reach down to the individual Departments, which will need to articulate their own priorities and plans to manage their own programmes, in accordance with the general strategic goals. The process is an interactive one, with the experience and thinking of the Departments contributing to and sharing ownership of the overall strategic plan. [6.8]

It is important for the continued productivity and success of the RERF programme that external peer review on an intensive basis be established, with a committee of experts chosen from each discipline to review each of the programmes once every five years. The external review committee should have time to assess individual protocols, to review them in concert with the investigators, and then to make recommendations about the future direction of the programme. This mechanism would not only stimulate investigators to improve their projects by exposing them to concentrated critique and discussion with outstanding experts in the field, but would also encourage them to discontinue projects that seemed non-productive. [6.9]

RECOMMENDATION 16

In the context of the current organisational structure, we recommend that successive five-year Strategic Plans, with annual updates, be developed and offered through the Executive Committee for approval by the Board of Directors.

RECOMMENDATION 17

We also recommend a new peer review process be established with multinational teams reviewing each Department every five years, each team being chaired, for example, by a different member of the Science Council.

RECOMMENDATION 18

We recommend that the Science Council takes a more active role with a closer involvement in the assessment and guidance of RERF. Its membership should reflect all of the major disciplines involved in the work of RERF. We further recommend that appointment to the Council be for 5 year terms, with no more than a single reappointment, and that two members retire each year.

7. NATIONAL AND INTERNATIONAL COLLABORATIONS

Currently, there is a group of strong and effective leaders and well trained support staff at RERF. A stable cadre of personnel, with the flexibility and capacity to replace those lost by attrition (especially in Statistics and Epidemiology), is essential. One of the problems of RERF inheres in the culture of Japanese institutions, whereby a relatively fixed cohort of workers is predictable because of lifetime guarantees of jobs. This obviously has its strengths, but it also has its limitations, both in preventing RERF from responding quickly, and in limiting personnel openings to new developments in basic science that may have an impact on the RERF programmes. It would be advantageous for RERF if a process could be established for short-term appointments from within Japan, possibly through collaboration with the universities. [7.1]

In particular, stronger links with universities or other research institutions, especially the universities at Hiroshima and Nagasaki, may be appropriate. These would provide the possibility of PhD students becoming involved in RERF research activities since there are sufficient data for a number of original research studies. Links could be foreseen with mathematical, physical, biological, epidemiological and medical sciences on both radiation and non-radiation related research. In comparison to Hiroshima, some links already exist between RERF Nagasaki and Nagasaki University, with papers being co-authored by staff from both organisations. [7.2]

The Governor of Hiroshima Prefecture is considering the construction of a cancer centre in Hiroshima city. Were this to proceed, participation in the planning by RERF would be profitable for the conduct of future work in epidemiology and clinical studies. [7.3]

Work on particular projects may be funded from research fellowships in Japan or, for example, from the Research Directorate of the European Commission (EC). The EC has a research programme into the health effects of ionising radiations which already involves support for projects in the former Soviet Union. Coordination with the work at RERF would seem logical to share scarce expertise from RERF and to try to elicit confirmatory data from other potential databases of occupationally or publicly exposed groups at Chelyabinsk and Mayak. By so doing, the Panel believes, RERF would become internationalised with support from Japan, Europe and the US. A particular problem that was described to the Panel and that particularly affects US cooperation, is the lack of career prospects in the US for those who return from a period at RERF. The Panel believes that this contrasts with the situation in the European Union where such practices are common. [7.4]

The Panel considers that it is not profitable and indeed positively inefficient for the practice to continue whereby within a single year somewhat in excess of 100 scientists can be imposed upon RERF for 2 or 3 days each. They learn an insufficient amount and distract the staff from their research programmes. A more structured exchange of fewer staff for longer periods would be an improvement, but careful selection of apt fellows is vital. [7.5]

CONCLUSIONS

While RERF is internationally known as a centre for radiation research, the results of its diverse programmes need to be more widely disseminated both in Japan and in the global scientific community. In order to continue the core research programmes of RERF, as well as the collaborative studies, recruiting and maintaining a strong and motivated scientific staff is a vital objective. It would be advantageous to seek short term appointments from other institutions in Japan, as well as to strengthen interactions with universities, especially those in the locality, and to enter into some additional formal overseas arrangements. [7.6]

RECOMMENDATION 19

We recommend that consideration be given to formal links being established, or strengthened, to universities or other research institutions in Japan and especially to the universities in Hiroshima and Nagasaki, with RERF Department Chiefs having visiting or part-time Professorships and undertaking teaching commitments together with PhD students being involved on projects at RERF.

RECOMMENDATION 20

In addition to the bilateral arrangements between Japan and the US, we recommend that consideration be given to RERF entering into formal programmes of exchange of research fellows with other countries and with regional or international bodies.

RECOMMENDATION 21

We recommend that, in view of the accumulated knowledge at RERF, it be developed as an Information Centre to promote informed public understanding of the risks of radiation.

8. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 3. THE POPULATION (Para 3.4).

The population studies at RERF are unique not only because of the type of exposure received by such large numbers of subjects, but also because the quality of the information recorded about each individual is extremely high. It seems unlikely that a comparable opportunity to study the effects of ionising radiation on health in such a detailed way will present itself in the future: and even if it does, it will take 50 years to accrue as much information as now exists at RERF.

CHAPTER 4. REVIEW OF THE SCIENTIFIC PROGRAMME

EPIDEMIOLOGY (Para 4.12)

The data held by the Departments of Epidemiology are of enormous importance, not only for assessing the effects of radiation on health, but also for determining the influence of various lifestyle factors on health and their interactions with radiation exposure. There is currently insufficient effort available to analyse the data and present reports, and much of the potentially valuable information collected has so far not been fully utilised.

RECOMMENDATION 1

We recommend that the Departments of Epidemiology should continue to collect data on mortality and cancer incidence and that they be strengthened. The management of RERF should give these studies the highest priority in view of the size and scope of the data. In addition,

research should be carried out by collaborating with epidemiologists from other institutions both in Japan and elsewhere, so that the full range of potentially valuable information already collected can be analysed.

STATISTICS (Para. 4 18)

Highly successful work has been performed in the Department of Statistics, which is a source of great strength for the entire organisation. Its input has been essential in making the accumulated data sets the worldwide basis for the estimation of human radiation risks.

RECOMMENDATION 2

We recommend that the Department of Statistics should continue to produce analyses of the risks of radiation exposure in collaboration with the Epidemiology Departments and that the high quality of the research in the Statistics Department be maintained.

RECOMMENDATION 3

We recommend that the Department of Statistics should continue to make available basic data sets on mortality and cancer incidence for analysis by other groups. This should now be extended to making available those data sets relating to mental retardation, IQ, and related outcomes of exposure *in utero*.

INFORMATION TECHNOLOGY (Para. 4.27)

Efficient data management and computing are the backbones to the success of research at RERF. The Panel believes that RERF has taken the right strategic decisions with respect to computing infrastructure, and the Department has gone about implementing them with considerable skill and intelligence. Impressive progress has been made over the last few years in creating a central linked database.

RECOMMENDATION 4

We recommend that strong support continue to be given to the Department of Information Technology because it is essential that the large body of data collected over many decades is properly stored, documented and accessible to researchers at RERF.

CLINICAL STUDIES (Paras. 4.37, 4 38)

The importance and merit of the research lies largely in the size and quality of follow-up of the LSS and AHS populations, the quality of the epidemiology and statistics as they relate to the LSS and AHS groups, and the continuing assessment of *in utero* exposed survivors. The role of the Departments of Clinical Studies is central to attaining many of the goals of all divisions.

The content and quality of the research lies in the collaborative role that the Departments play with all other Departments:

☐ by providing clinical data on fatal and non-fatal carcinomas and on non-cancer effects of radiation exposure;

☐ by enabling in-depth investigations of associations to be observed in the LSS;

☐ by furnishing a unique pool of serum, plasma and lymphocyte samples; and

☐ by providing an essential "bridge" function to the survivors.

RECOMMENDATION 5

We recommend that while many of the Clinical Studies projects under way should be extended, the programme should be critically reviewed so that those which are not promising are discontinued. The continuing surveillance of the cohort who were children in 1945 and are now adults is likely to be revealing, since radiation sensitivity may be highest in the young.

RECOMMENDATION 6

We recognise that the AHS is vital to the wellbeing of the survivors and we recommend that this important service continue, since we believe it has led to their high level of cooperation with RERF. As the population ages, and health problems become more complex, consideration needs to be given to ensuring that the voluntary participation remains high.

GENETICS (Paras. 4.47, 4.48)

While molecular biology investigations will enable the most detailed determinations to be undertaken, and will thus be the focus of future work, there is nevertheless need to continue - and even to extend - the more conventional studies of the health of the offspring (F_1 generation). They will also have continued importance because it remains uncertain at what point molecular studies can come sufficiently close to the resolution of the problem of multifactorial hereditary damage produced by radiation.

It does now appear that there can be a more complete chain linking the evolving physics dosimetry and individual data on location at the time of the bombing to chromosome data, to tooth data, and data from solid state dosimetry on other objects, such as building materials, ceramics, or jewellery. While dosimetry has traditionally not been the task of RERF, these new interconnections will be very important for validating the DS86 dosimetry system.

RECOMMENDATION 7

We recommend that the studies on the health of the offspring (F_1 generation) of the survivors continue, since they may elucidate data on multifactorial disease while also providing direct benefit to the survivors and their offspring.

RECOMMENDATION 8

We recommend the preservation of biological samples for FISH analysis and for ESR, together with the documentation that will be needed to compare dose estimates based on biological samples with those from physics assessments.

RECOMMENDATION 9

We recommend the continuation of the storage of biological materials and associated documentation for future molecular genetic studies.

RECOMMENDATION 10

We recommend that the most advanced methods and expertise in cytogenetics continue to be available at RERF.

RADIOBIOLOGY (Paras. 4.53 - 4.57)

The archives of tumour and normal tissue material for molecular and biological studies from A-bomb survivors are of great importance in view of developments in molecular biology, and the extension and upkeep of the repositories is a central task for RERF.

The particular strengths of the immunology studies at RERF are the repeated observations in groups of A-bomb survivors that extend over sufficiently long periods to demonstrate the effects of aging, and the combined effect of aging and radiation exposure on the immune competence of T-cells. Recent studies on clonal expansion are of special interest.

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Programme management in a research environment such as RERF requires a deftness of touch to ensure that the processes are not so formalised and heavy handed that they obstruct the development of new ideas. Nevertheless, it has been the experience in other establishments that overall strategic planning and a firm commitment to fairly detailed programme management is needed to secure the best outcomes in the present (worldwide) climate of constrained resources. In practical terms, the plan will reach down to the individual Departments, which will need to articulate their own priorities and plans to manage their own programmes, in accordance with the general strategic goals. The process is an interactive one, with the experience and thinking of the Departments contributing to and sharing ownership of the overall strategic plan.

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CHAPTER 7. NATIONAL AND INTERNATIONAL COLLABORATIONS (Para. 7.6)

While RERF is internationally known as a centre for radiation research, the results of its diverse programmes need to be more widely disseminated both in Japan and in the global scientific community. In order to continue the core research programmes of RERF, as well as the collaborative studies, recruiting and maintaining a strong and motivated scientific staff is a vital objective. It would be advantageous to seek short term appointments from other institutions in Japan, as well as to strengthen interactions with universities, especially those in the locality, and to enter into some additional formal overseas arrangements.

RECOMMENDATION 19

We recommend that consideration be given to formal links being established, or strengthened, to universities or other research institutions in Japan and especially to the universities in Hiroshima and Nagasaki, with RERF Department Chiefs having visiting or part-time Professorships and undertaking teaching commitments together with PhD students being involved on projects at RERF.

RECOMMENDATION 20

In addition to the bilateral arrangements between Japan and the US, we recommend that consideration be given to RERF entering into formal programmes of exchange of research fellows with other countries, and with regional or international bodies.

RECOMMENDATION 21

We recommend that, in view of the accumulated knowledge at RERF, it be developed as an Information Centre to promote informed public understanding of the risks of radiation.

ANNEX I.
MEMBERSHIP OF THE PANEL

CHAIRMAN OF THE PANEL
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Director
National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ, UK

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Dr. WATARU MORI
President
Japanese Association of Medical Sciences
The Council for Science and Technology
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President of the Board of Directors
National Board of Nuclear Regulation
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Dr. KEITH H. LOKAN
Director
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Chairman
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Dr. HERBERT L. ABRAMS
Professor of Radiology
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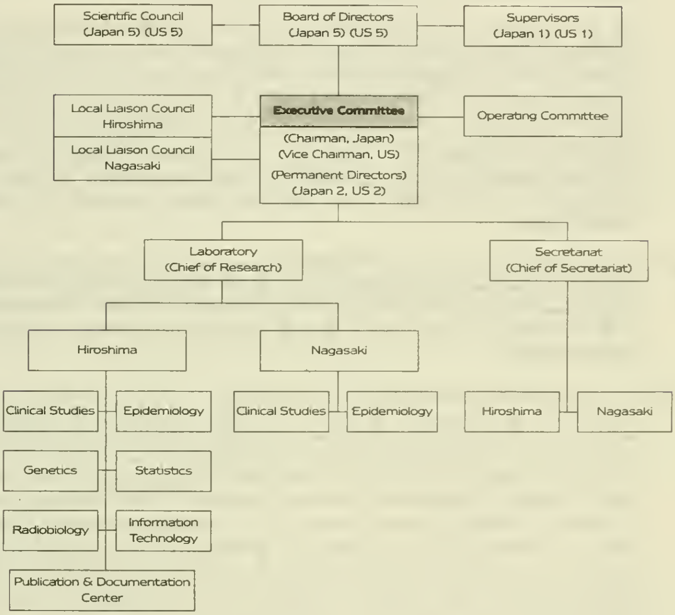
TECHNICAL ASSISTANT TO THE PANEL
Dr. COLIN R. MUIRHEAD
National Radiological Protection Board, Chilton, Didcot, Oxon OX11 0RQ, UK

ANNEX II
ORGANISATIONAL STRUCTURE OF RERF


Scientific Council (Japan 5) (US 5)
Board of Directors (Japan 5) (US 5)
Supervisors (Japan 1) (US 1)
Local Liaison Council Hiroshima
Local Liaison Council Nagasaki
Executive Committee
(Chairman, Japan)
(Vice Chairman, US)
(Permanent Directors)
(Japan 2, US 2)
Operating Committee
Laboratory (Chief of Research)
Secretariat (Chief of Secretariat)
Hiroshima
Nagasaki
Clinical Studies
Epidemiology
Genetics
Statistics
Radiobiology
Information Technology
Publication & Documentation Center
Clinical Studies
Epidemiology
Hiroshima
Nagasaki

Q9. DOE's 1997 request for the Radiation Effects Research Foundation is $15.0 million, a 25 percent reduction from the FY 1996 funding level of $20.0 million. On page 140 of Volume 2 of the FY 1997 Congressional Budget Request, it is stated that the Department will "[i]mplement 25 percent cost savings measures identified in FY 1996."

What are these specific cost savings that have been identified?

A9. DOE's 1997 request for the Radiation Effects Research Foundation is $15 million, a 25 percent reduction from the FY 1996 funding level of $20 million. On page 140 of Volume 2 of the FY 1997 Congressional Budget Request, it is stated that the Department will "[i]mplement 24 percent cost savings measures identified in FY 1996."

The cost savings have been predominantly realized from a modified funding arrangement agreed upon by the Department of Energy and the Japanese Ministry of Health and Welfare on June 21, 1996. The arrangement redefines the cost-shared portion of the RERF budget such that the costs of the clinical services provided atomic bomb survivors and studies of their children will now be borne exclusively by the Japanese government (resulting in the reduction of the amount to be co-funded by the U.S. of about $9-$10 million/year, or one-fourth of the total RERF budget). Additionally, the Department of Energy, the NAS, and the Japanese Ministry of Health and Welfare, are committed to working, this year and in upcoming years, with the RERF, to put into effect additional personnel and operations costs reductions.

Q10. On page 142 of Volume 2 of the FY 1997 Congressional Budget Request, it is stated that $2.0 million has been provided in each of FY 1995 and FY 1996 for "Contract Reform" and that an additional $2.0 million is requested in FY 1997. That appears to be $6.0 million over three years to include some standard clauses in contracts. Please elaborate.

A10. The contract reform initiative helped to start a transition in DOE of increasing contractor accountability for performance of work. This effort included the development and evolution of special contract clauses which ensured the appropriate assignment of responsibility and accountability for ES&H performance. Now that most of DOE's contracts for managing and operating facilities include the new contract clauses, the next step is to facilitate implementation. The efforts planned for FY 1997 include this step and are twofold: (1) ensuring that line managers have the management processes and tools in place to incorporate ES&H into all aspects of business, including providing information necessary for preventive risk management; and (2) establishing accountability mechanisms to ensure and reward line ownership for ES&H performance, including declaration of DOE ES&H expectations, formal contractor commitments to planned ES&H performance, and performance measures. The full use of these mechanisms is critical for ensuring the adequate protection of workers, the public, the environment, and DOE's assets. This is an on-going undertaking which requires working with all DOE elements, Headquarters and field offices, at all levels of business management. We have learned many lessons already from the contract reform activity, but we have more to learn. These lessons must now be incorporated into the way DOE carries out its mission which means continuously improving our techniques of contract management. The planning for FY 1997 includes this undertaking as we work with the different sites and facilitate the learning of processes to ensure implementation and the sharing of information across the complex. Complicating this approach is the variety of activities and hazards which currently exist at DOE sites. Additionally in FY 1997, we anticipate required support for potential procurements at Oak Ridge and the Los Alamos National Laboratory and for performance measures and incentives development related to ES&H management. Considering the fact that DOE's total budget is approximately $15 billion, the $2 million planned to ensure the continued safe performance of DOE's contractors is a worthwhile investment. If we stop this effort now, we will have only come a part of the way. It is imperative that the gains made in ES&H performance be built upon for future so this Department can attain the level of ES&H performance and protection which has come to be expected.

Rear Admiral Richard J. Guimond
Principal Deputy Assistant Secretary for Environmental Management
U.S. Department of Energy

Followup Questions and Answers

HEARING OF THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

on

The Department of Energy's FY 1997 Budget Requests for Environment, Safety and Health, Environmental Restoration and Waste Management (Non-Defense) and Nuclear Energy

Wednesday, May 1, 1996

Followup Questions Submitted to

Rear Admiral Richard J. Guimond
Principal Deputy Assistant Secretary for Environmental Management
U.S. Department of Energy

Q1. Page 357 of the *Analytical Perspectives* volume of the Budget of the United States Government (H.Doc. 104-162/Vol. 3) show the following budget outlay profile for the DOE Defense Environmental Restoration and Waste Management: FY 1995 = $5.621 billion; FY 1996 = $5.237 billion; FY 1997 = $5.289 billion; FY 1998 = $5.021 billion; FY 1999=$4.603 billion; FY 2000 = $4.17 billion; FY 2001 = $4.291 billion; and FY 2002 = $4.787 billion.

Q1a. Did DOE participate in the development of these figures, and if so, how will the multi-hundred-billion dollar cleanup make any headway?

A1a. DOE did participate in the development of the outlay projections. Outlay share rates calculated by OMB and the agencies based on the historical spend out of budget authority. These rates are adjusted when program spend out changes or the agency or the Congress make substantial changes to a program. Furthermore, DOE believes that substantial progress can be made by focusing our resources on risk and mortgage reduction activities. The Environmental Management program has turned the corner and is focusing more on actual cleanup rather than the "paperwork" assessment phase.

Q1b. Do you concur that this funding stream is adequate to do the job?

A1b. DOE believes that this funding stream is adequate to do the job. However, subsequent to the submittal of the FY 1997 budget to Congress, Alvin Alm was confirmed by the Senate and sworn in as the new Assistant Secretary for the Office of Environmental Management. Assistant Secretary Alm subsequently proposed a new "Ten-Year vision" for the clean-up program. This vision states that within a decade clean-up will be completed at most EM sites in the DOE complex. This vision will drive budget decisions, sequencing of projects, and actual actions taken to meet program objectives. Two of the assumptions necessary to implement this vision are stable funding levels and the support of regulators and stakeholders.

Stable funding levels are necessary for accurate planning and sustaining real progress in reducing mortgages and cutting support costs to free up funds for further risk reductions. The initial results of the ten-year planning process will be available in the spring of 1997 and will provide the basis for our detailed budget estimates for the next decade.

Q2. What criteria do DOE use to decide whether a project should be funded by the non-defense portion of the Office of Environmental Management budget rather than out of the defense portion?

A2. The Environmental Management program was established in November 1989, by transferring activities from three DOE line organizations: The Office of Defense Programs (funded under the Defense appropriation), and the Offices of Nuclear Energy and Energy Research (funded under the non-defense appropriation). The decision for funding an EM project from a particular budget appropriation account is based on one or more of the several criteria. The first is specific statutory language, such as the Uranium Mill Tailings Remedial Action Project (separately authorized by Congress in 1978) or the West Valley Demonstration Project (separately authorized by Congress in 1980)–both funded entirely from the non-defense account.

In the absence of statutory language, identification of the present or past "owner" of the particular cleanup activity is considered in identifying the source of funding. For example, if waste is or was generated by Energy Research activities, Energy Research would be the "owner" and the cleanup would be funded out of non-defense sources. Also, the Formerly Utilized Sites Remediation Action Project (FUSRAP) is funded from the non-defense account because the responsible DOE line organization, prior to the establishment of the EM office, was the Office of Nuclear Energy which is funded primarily by the non-defense Energy Supply Account

A third criterion is the historical usage of the facility (civilian research and development or weapons production) by prior Departmental programs. The majority of Department sites are supported from the Defense appropriation account based on past efforts. However, some do have a mix of activities with certain projects supported by the non-defense account based on historical activities conducted. Some projects, e.g., the Brookhaven National Laboratory in New York and the Inhalation Toxicology Research Institute in New Mexico are entirely funded under the non-defense account because few defense-related efforts were conducted there.

Lastly, some projects had clear mission assignments at the time of origination (under DOE or its predecessor agencies), and even though the missions have changed, the projects continue to be funded based on historical practice.

Q3. At the bottom of page 4 and at the top of page 5 of your prepared testimony, you stated: "Shortly, we will provide a formal response to the NAS report, including specific plans to continue improving the management of this program."

How soon is "Shortly" and why has it taken so long to prepare a response?

A3. Attached for the record is the Office of Environmental Management's (EM) April 1996 response to the National Academy of Sciences' report Improving the Environment: An Evaluation of DOE's Environmental Management Program in April 1996.

IMPROVING THE ENVIRONMENT:

NEXT STEPS

Response to the
National Academy of Sciences' report:
IMPROVING THE ENVIRONMENT:
An Evaluation of DOE's
Environmental Management Program

The Office of Environmental Management
U.S. Department of Energy

April 1996

1. Introduction

As the largest environmental stewardship program in the world, the Department of Energy's (DOE) Environmental Management (EM) program faces unprecedented environmental and managerial challenges. The program is responsible for managing the chemical and radiological hazards from spent nuclear fuel and high-level nuclear waste; cleaning up tremendous volumes of contaminated soil and ground water; stabilizing, securing, and safely storing approximately 25 metric tons of plutonium and other nuclear materials; decontaminating and decommissioning a vast number of hazardous and radioactively contaminated industrial structures that are no longer needed; and maintaining an aggressive technology research and development program. According to its *1995 Baseline Environmental Management Report*, a DOE effort to identify the total life-cycle cost and time needed to accomplish these tasks, EM's mission is projected to cost more than $200 billion over the next 75 years. The federal budgetary climate indicates that EM will be required to complete its mission with, at best, stable funding.

The current budgetary outlook, combined with stakeholder expectations, Congressional directives, and external oversight, has led EM to refocus and improve the management of the program to ensure that EM can accomplish its mission in the most safe, efficient, and cost-effective manner. By adopting a performance-based management system, EM Headquarters, field sites, and contractors are changing the way of doing business to provide a worthwhile return on the taxpayers' investment and achieve the goals of the EM program within increasingly constrained budgets. Many of the management initiatives adopted during the past three years have produced significant cost savings and achieved progress in environmental restoration, waste management, and nuclear materials and facility stabilization, without sacrificing worker or public safety or creating additional environmental problems.

As part of the program's continuous efforts to improve, Assistant Secretary Thomas Grumbly has invited individuals from outside the Department to provide advice, critiques, and recommendations for improving the way EM does business. The Environmental Management Advisory Board (EMAB), made up of individuals from industry, academia, and environmental groups, was established to provide recommendations directly to the Assistant Secretary. Eleven sites across the complex now have Site-Specific Advisory Boards (SSABs) that provide input on cleanup activities, future land use, budget, and other decisions at the site level. Other organizations, including the National Academy of Sciences (NAS), have been part of this ongoing effort to improve the program.

In January 1995, Assistant Secretary Grumbly specifically requested the NAS to examine the scientific, engineering, and institutional barriers to achieving a more cost-effective program and to make recommendations for improvement. EM welcomes the NAS findings and recommendations, presented in their study *Improving the Environment*[1], as a valuable contribution towards further improvements in EM program management. The NAS report focuses on (1) evaluating regulatory measures; (2) setting priorities, timing, and staging; (3) using science, engineering, and technology; and (4) integrating of science, engineering, and health in the implementation of EM.

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[1] Pages cited in this document are from *Improving the Environment: An Evaluation of DOE's Environmental Management Program*, Committee to Evaluate the Science, Engineering, and Health Basis of the Department of Energy's Environmental Management Program, National Research Council, 1995, National Academy Press, Washington, D.C.

The NAS concludes that "[a] number of [EM's] initiatives are rapidly introducing change into a system that was established during the Cold War. . . [EM's] principles and general direction are encouraging." (p. 7) As part of its principal recommendations, the NAS also states that for continued progress EM should implement a process for decisionmaking and accountability that includes:

- More specific goals for the program;
- A method for prioritizing tasks;
- Benchmarks to measure performance and performance-based standards and incentives;
- A peer-reviewed remediation and waste minimization technology selection and development process that is responsive to the needs of those implementing the remediation; and
- An overall organization and management structure that allows for stakeholder input for each of these activities. (pp. 10-11)

EM has already established some elements of such a process, but recognizes that a number of areas need further development. EM plans to implement five specific NAS recommendations to improve its overall program management. A discussion of these plans follows.

2. EM Implementation of NAS Recommendations

To determine how best to move forward with the NAS recommendations, EM identified those issues that could be implemented in fiscal year (FY) 1997, as well as provide the greatest return on resource investment and improve consistent performance-based management. While EM is currently engaged in activities in each of the selected areas, the NAS report provides an opportunity for the program to focus greater attention on these activities, and where necessary, provide an impetus for action. The five recommendations for near-term implementation are:

(1) Develop a system that rewards performance and increases accountability;
(2) Establish a more consistent priority-setting process to be reflected in the budget;
(3) Focus environmental science and technology development on EM's needs, ensuring science and technology selections are competitive and peer-reviewed, and ensuring basic research is targeted to technology needs;
(4) Implement a charge-back system for waste management services; and
(5) Work collaboratively with states and the U.S. Environmental Protection Agency (EPA) to establish a lead regulator and to improve regulatory flexibility.

Appendix 1 presents a summary of each recommendation, current activities, and future actions.

Although EM will focus on implementing these recommendations in the short-term, the NAS also raised issues that will require longer-term, strategic actions, such as future land-use planning and responsible stewardship. These two issues are fundamental to decisions about cleanup, risk management, priority setting, budget formulation, and performance incentives. Moreover, EM recognizes that responsible stewardship and land-use planning are integrally linked and must be managed jointly. For example, the value of alternative future land uses must be balanced against the cost (in dollars and increased worker risks) required to achieve the cleanup levels necessary to make those uses possible. In addition, aggressive remediation in some cases may disturb the ecology but provide little or no benefit to public health. EM must work with stakeholders and sites to articulate these sensitive and critical trade-offs.

Given the complexity of these issues, EM's longer-term actions will require further internal and external discussion; therefore, they are not fully addressed in this response. In brief, EM agrees with the NAS finding that "the lack of appropriate technology or permanent solution for remediating a polluted site or facility should not be an excuse not to take appropriate steps on a near-term or interim basis," (p. 11) and the report pointed out cases where, in fact, EM is making progress by taking interim actions even though no final plans may have been determined. EM is addressing both responsible stewardship and land-use planning in its Strategic Plan. In addition, EM will release the *Future Use Summary Report* in the next few months, which depicts the assumed future use of sites as currently envisioned by the Department and stakeholders. The report presents future-use "maps" developed by sites, their SSABs, and other stakeholders. In the *1996 Baseline Environmental Management Report* to be released in May, EM is evaluating different land use assumptions to estimate the total cost of remediation. EM is committed to building upon these efforts until future land and facility use become fully integrated into the budget process and site strategic initiatives. These efforts will proceed in full partnership with stakeholders.

2.1 Develop a System that Rewards Performance and Increases Accountability

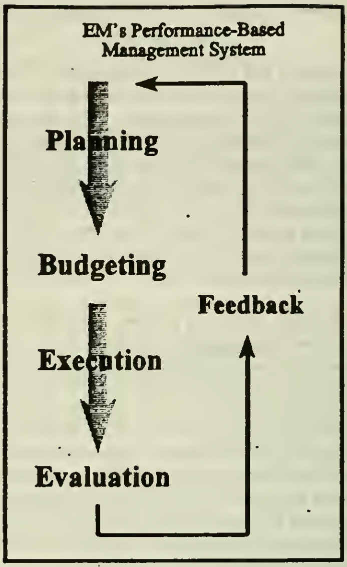
The NAS commended EM for the steps it has taken in the area of performance-based management, including progress it has made in reforming contracts and measuring performance against outcomes rather than day-to-day activities. However, the NAS notes that EM's current system does not appear to have clear measures of progress or hold managers accountable for achieving progress. In addition, the report makes clear that DOE, like most federal agencies, lacks strong incentives for improved performance, and even has some deeply rooted disincentives.

Over the past few years, EM has begun implementing a performance-based management system, consistent with recommendations from the EMAB and the NAS. This system is designed to:

- Align strategic and operational planning;
- Establish policies and clear roles and responsibilities;
- Ensure that planning drives resource allocation; and
- Provide for systematic evaluation of results and feedback.

Using this iterative process involving strategic planning, budget formulation, program execution, and performance evaluation, EM is improving and adapting program priorities, activities, and performance. EM is seeking stakeholder input at a variety of stages in this process, including strategic planning and budget formulation.

EM recognizes that its management system must continue to improve, and agrees that it must address the problems highlighted by the NAS. The following section discusses some of EM's accomplishments in this area and presents activities planned for further progress.


EM's Performance-Based Management System

ACCOMPLISHMENTS TO DATE:

- EM is clarifying its goals and expectations of the programs and sites. EM is revising its Strategic Plan, with input from the EMAB and other stakeholders, to clarify its program mission and vision, identify key strategic and management initiatives, and formulate a system for prioritizing EM activities. Individual program offices, such as Waste Management, Environmental Restoration, and Nuclear Materials and Facility Stabilization, have developed or are developing program-specific strategic plans based on the EM Strategic Plan. These plans are also consistent with the EM Annual Performance Plan, which provides the direct link between broader goals in the Strategic Plan and the accomplishments EM managers are expected to achieve in conducting their daily business. This plan identifies performance targets, such as volume of waste disposed and number of completed remediations. In addition, each program office, in consultation with project managers at sites, establishes annual site-specific goals.

- EM is measuring its performance against the "Critical Few." In early 1995, EM recognized that the abundance and continued proliferation of performance measures was causing management confusion and inefficiency. To address this problem, a team developed the "Critical Few," which not only incorporates Government Performance Results Act (GPRA) measures, but goes even further in setting forth specific goals. The five measures comprising the Critical Few are: (1) mission completion (outcome-oriented); (2) business/leading indicators; (3) major milestones; (4) trust and confidence; and (5) safety and health. The results from EM program performance against these Critical Few measures will be reported in the second EM Quarterly Management Review (QMR) for FY 1996.

- EM has conducted several "benchmarking" efforts with external partners, including other federal agencies and private industries. EM has begun to use standard industry "benchmarks" to measure the performance of its programs in comparison to other organizations that have similar challenges. In applying benchmarking methodologies, EM is benefiting from the experience of benchmarking efforts in the private sector. Recent efforts include the Project Performance Study (1993), Benchmarking for Cost Improvement Study (1993), Remedial Investigation/Feasibility Study (RI/FS) Benchmarking Study (1995), the Program Management Benchmark (1995), and the Environmental Management Benchmarking Guide (1995). In addition, EM has conducted a Facilities Benchmarking study at the Fernald Site to establish a target for 29 major categories of landlord and program management costs. These targets are based on comparisons with other DOE sites, other government organizations, and private industry. The Facilities Benchmarking effort has been expanded to examine support costs across programs and sites; it will incorporate Financial Management Systems Improvement Council (FMSIC) data on site support costs, which are broken out by cost category, fiscal year, and direct/indirect funding sources.

- EM is renegotiating and recompeting contracts to reward performance. The NAS report specifically acknowledged the new performance-based contract at the Rocky Flats Environmental Technology Site. DOE has also made significant progress in implementing performance-based contracts at other sites. At the Fernald Site, the contractor receives a 20 percent base fee and 80 percent performance-based fee. Other sites are similarly renegotiating or recompeting their management contracts (e.g., Richland will soon issue a performance-based request for proposal for the Hanford Site). EM is also reforming its Headquarters support contracts to award contracts based on performance.

- EM is using reporting and feedback mechanisms to improve overall program management. The EM Annual Performance Report and the QMR are the primary tools used by EM to incorporate information from performance measurements back into strategic planning. The Annual Performance Report measures progress against the Annual Performance Plan and then communicates the results to the Office of Management and Budget and Congress. EM will also use the QMR to train EM employees in desired program metrics and performance standards, educate staff on performance incentives. The goal is to transform EM into a more outcome-oriented organization.

- EM's "work-out" sessions have brought together Headquarters, field, and contractor managers and senior representatives of federal and state regulatory agencies to find more cost-effective ways to meet mutual environmental goals. A series of these "work-out" sessions was initiated in April 1995. This site-by-site effort has enabled EM and other participants have identified opportunities to reduce costs, increase efficiency, find innovative solutions to regulatory challenges, and define better ways of managing resources and environmental objectives. Sites for which work-out sessions have been conducted have identified specific FY 1996 cost savings targets and efficiency improvements. EM will also share the lessons learned from these sessions with other sites across the complex.

ACTIVITIES FOR FURTHER PROGRESS:

- EM will develop an integrated management plan. A newly established Process Improvement Team, made up of senior managers in program and field offices, will work to improve and integrate managerial and financial tools, consistent with the broader goals outlined in the EM Strategic Plan. Many of EM's tools have been developed as specific needs arose. For example, Activity Data Sheets were created as the fundamental data for budget requests; then Risk Data Sheets were developed in response to a Congressional request and were later used to incorporate risk reduction into the budget process. As the NAS points out, EM must improve the harmony and integration of these and other tools. The Process Improvement Team has begun by focusing on the integration of specific roles and responsibilities of the field and Headquarters to better align management tools. The Process Improvement Team will provide recommended improvements to the Assistant Secretary by September 1996.

- EM will reward progress at sites through performance recognition allocations. A key element of performance-based management is to reward sites for their accomplishments. EM is currently investigating options for basing future budget allocations on historical performance, as reported in the Annual Performance Plan. EM would direct additional resources to sites that have demonstrated high levels of performance and have developed a proposal for accelerating work Another reward mechanism could include sending future high-profile projects to sites that have demonstrated their ability to perform

- EM will continue to expand contracting reform efforts broadly across the program. In addition to renegotiating and recompeting contracts at sites, EM will train personnel to manage performance-based contracts (e.g., in management, measurement, and setting goals), using lessons learned across the DOE complex to improve program execution and connect contractor award/incentive fees to tangible outcomes more closely. EM will specify measurable results for the contractor, but will not prescriptively define the process the contractor must use. For example, the contractor will have the latitude to select the best technology to meet the goals outlined in the contract and to comply with applicable regulations.

- EM will explore the development of a pilot program and incentives to reward employees for outstanding performance. The NAS recommends initiating a pilot program with the DOE Office of Personnel and the Office of Personnel Management (OPM) to create a civil-service program with greater incentives for performance. A letter from the Assistant Secretary requesting the assistance of the DOE Office of Personnel and OPM to explore the development of such a program will be sent out no later than June 1, 1996 This effort will be in conjunction with the DOE Strategic Alignment and Reinventing Government initiatives. Further, EM will develop guidance for incorporating program performance measures into *all* employee performance standards, not just those for Senior Executive Service employees, by the end of FY 1997.

- EM will use benchmarking and other methods to reduce costs. EM will establish standard industry benchmarks for performance, including unit cost ranges for support costs for FY 1996 and beyond. Once these benchmarks are established, EM will be able to analyze key business processes to determine how private industry achieves these performance levels and apply similar strategies for improving performance within EM. EM will consult with industry sources for such benchmarks, including engineering and design companies, chemical and manufacturing companies, commercial nuclear power utilities, DOD (e.g., naval nuclear shipyard), and professional associations (e.g., International Facilities Management Association). EM will refine and finalize preliminary standards and use them to set best practices and performance goals. In support of these efforts, EM is analyzing Financial Management Systems Improvement Council (FMSIC) data to establish internal performance standards to facilitate direct comparisons of performance among Operations Offices.

- EM will encourage creative management approaches through effective training. Training programs will emphasize achieving outcomes instead of prescribing processes or remedies. Training programs will include project management tools, benchmarking, incentive contracting, and cost validation techniques. EM will also emphasize technical training to maintain and increase the competence of technical staff across the complex.

2.2 Establish a More Consistent Priority-Setting System to be Reflected in the Budget Process

One of the most critical issues raised by the NAS was the need for EM to establish a priority-setting system with the following attributes: consistency, coherence throughout the Department's complex, feedback for evolutionary system, clarity and transparency, and stakeholder involvement. (pp. 18-19) This section focuses primarily on priority-setting in formulating the EM budget. In an effort to achieve an appropriate balance of priorities between the national and site-specific perspectives, EM is engaged in an iterative, evolutionary process that is being enhanced through meaningful stakeholder participation. The NAS favorably describes this process as "unique." However, EM acknowledges the NAS recommendations for more clearly-stated goals, greater stakeholder involvement at national and local levels, and better transparency and consistency in the EM priority-setting system.

ACCOMPLISHMENTS TO DATE:

- EM's program priorities for budget formulation have evolved over time and now include risk reduction, cost-effectiveness, including "mortgage reduction," compliance, and stakeholder concerns. Earlier in the program, the main programmatic priority was to fund those activities necessary to meet compliance agreements and other regulatory requirements. In FY 1995, EM introduced Risk Data Sheets into its planning process in an effort to better gauge the extent to which its programs were addressing health and safety risks to workers and the public. In FY 1996, as part of the FY 1998 Internal Review Budget process, EM expanded Risk Data Sheets to include consideration of compliance, mission impact, mortgage reduction, and social/cultural/economic impacts. Field offices are also required to develop and submit budget cases not only on risk reduction, but also on mortgage reduction, compliance, and stakeholder concerns. Using lessons learned from implementing this budget prioritization policy, EM has refined and improved the qualitative risk assessment process for the FY 1998 budget.

- EM is continuing to balance local and national goals in the budget process. The current budgetary prioritization process represents a balance between the two facets of EM. On the one hand, the budget process is a "bottom-up" prioritization process: field offices, which are those most knowledgeable within the DOE complex about the conditions at their respective sites, are delegated the initial responsibility for developing the budget requests for those sites. On the other hand, the process reflects a "top-down" national perspective, since the broad programmatic goals and budgetary criteria that lead to the final EM budget preparation are initially established on a national basis. The final EM budget is a blending of local considerations and national perspectives. EM is currently updating its Strategic Plan, which will define its mission and vision and clarify programmatic goals. The continued interaction between "bottom-up" and "top-down" approaches has been instrumental in establishing and refining clearer program goals.

  Because local considerations can be diverse, many sites have developed and used ranking systems tailored for their individual needs. For this reason, while consistent evaluation criteria are important to national program decisionmaking, EM does not focus on a rigid ranking system for all sites across the complex.

- EM is involving stakeholders in the budget process. According to the NAS, "The Secretary has taken steps to involve people affected by the Department's actions in the decisionmaking process. That has been successful and should be continued formally." (p. 19) Starting in FY 1996, EM has progressively increased the involvement of stakeholders in the budget formulation process For FY 1997, the Office of Management and Budget granted special permission to EM to allow stakeholders to participate in budget formulation. For the FY 1998 budget formulation process, which is currently under way, sites are required to involve their stakeholders throughout the process of developing budget requests. For example, the Hanford Site assembled a "Consistency Team" to develop its site priority lists and Hanford Risk Data Sheets; this team included site personnel, Headquarters representatives, state regulators, Tribal representatives, and members of academia Each of the Headquarters program offices will evaluate these site-specific priority lists to determine their consistency and compatibility with the national programmatic goals and objectives in each program area. At EM's Internal Review Budget meeting in May of each year, the Operations Office managers and the Headquarters senior program managers resolve any outstanding issues or conflicts raised by the national program reviews of the proposed site budgets. Last year, national stakeholders were invited to the Internal Review Budget meeting. In addition, the Assistant Secretary will convene a meeting with the states, represented by the National Governors Association, to receive feedback on how EM has gathered and considered states' issues during the current budget development process.

EM has involved other stakeholders, including SSABs and the EMAB, in the budget and priority-setting process. In addition, EM has participated in two Federal Facility Environmental Restoration Dialogue Committee efforts on priority setting and has embraced the concepts adopted by this Committee.

- EM is using external peer review to refine risk data and other information for budget formulation. Based on the EMAB recommendations, EM is implementing a three-tiered approach to improve the quality of information for budget priority-setting: (1) a group of experts, stakeholders, and regulators are developing guidance for integrating risk, long-term costs, future land-use, and stakeholder involvement in the budget for FY 1998; (2) DOE sites are forming "consistency teams" with cross-site and stakeholder members to implement the process and review the results on a local and national level; and (3) individuals in the first and second tiers and other experts will evaluate the process in late spring of this year for application in the next fiscal year

  In addition, EM is supporting a cooperative agreement with the Consortium for Risk Evaluation and Stakeholder Participation (CRESP), which includes universities and other academic institutions, private environmental consulting firms, and labor organizations. This agreement will provide a mechanism for external peer review of risk assessment and risk management activities.

ACTIVITIES FOR FURTHER PROGRESS:

- EM will continue to set more clearly stated cleanup goals through strategic planning, future land-use efforts, and other initiatives. The NAS states that EM needs more "clearly stated goals" that include information on what the organization is trying to achieve in the short- and long-term. (p. 59) As stated earlier, EM is revising its Strategic Plan to clarify its mission, set the vision for the program, identify key strategic initiatives, and formulate a system for prioritizing activities. EM also recognizes the critical role of land-use planning in setting long-term program goals and is developing future land-use plans at its sites. As of January 1996, 15 sites have developed future land-use recommendations with their stakeholders. At the Fernald Site, for example, citizens' recommendations for the future land use at that site have enabled the Department to move forward on cleanup at a cost of approximately $1 billion less than originally estimated. In addition, EM will integrate data and analytical techniques from the *Baseline Environmental Management Report*, including future land-use and mortgage reduction, into the FY 1999 budget. EM is also working with the Administration on Superfund reform proposals to incorporate land-use decisions in remedy selections and to develop general cleanup goals.

- EM will expand its annual lessons-learned meetings to discuss how to improve priority setting in the budget process and the effectiveness of involving stakeholders at each site. The lessons-learned meeting for FY 1998 will be conducted in the summer of 1996, following the Internal Review Budget meeting in May. During this meeting, EM will seek constructive feedback on ways to improve the budget formulation process, including stakeholder involvement at the site level. Early feedback on the FY 1998 process demonstrates that opportunities for stakeholder involvement continue to be limited in some locations. The input from this meeting will be incorporated into the EM strategic planning efforts and in the guidance for FY 1999 budget formulation. All Headquarters programs and field offices will be involved in this meeting.

- For the FY 1999 budget process, EM will develop a uniform definition of "activity" across the complex to allow more accurate site and program comparisons. The NAS observed that EM inappropriately "bundled" activities in the FY 1997 budget formulation process (i.e., lumping dissimilar things into packages that are then thought of as constituting a single activity). (p. 77) While EM recognizes that activities for FY 1997 may have been inappropriately grouped together, this bundling was due in part to the lack of a universal EM definition of "activity." The FY 1998 formulation guidance provided a definition but gave the field latitude in how it was applied EM will evaluate the FY 1998 budget process to determine to what extent improper bundling can be avoided and to incorporate lessons learned into the FY 1999 budget process

  As part of this evaluation of activities, EM is making changes to its Risk Data Sheets, which rank activities according to different risk categories. For example, EM has added a "social/cultural/economic" evaluation category, and reworked the "mortgage reduction" category. Furthermore, EM will consider requiring the development of the field's integrated priority list at the "Risk Data Sheet" level for FY 1999. EM will evaluate these data sheets for the FY 1998 budget to determine other changes that might be necessary for FY 1999. In addition, EM's Environmental Restoration program has implemented an initiative to manage and track its performance at the release site and facility level of detail. For the FY 1998 budget, EM will have identified the relative risk of its release sites and facilities.

2.3 Focus Science and Technology Development on EM's Needs, Ensure Science and Technology Selections are Competitive and Peer-Reviewed, and Ensure Basic Research is Targeted to Technology Needs

The NAS discussed the need for better integration of science and technology into the needs of EM in two specific areas. First, according to the NAS, EM's approach to five priority "focus areas" for technology development provides "an appropriate structure...However, ... [it] has fallen short of the intended mark primarily because users, researchers, and developers have not yet been fully integrated into the decision making process for selecting new technologies." (p. 21) Second, the NAS states that universities, industry, and national laboratories should be involved in technology issues through a competitive, peer-reviewed process.

ACCOMPLISHMENTS TO DATE:

- EM has established and is adapting its focus areas to meet EM's needs. As the NAS pointed out, five "focus" areas were established in 1994 to meet DOE's most pressing environmental technology needs: high-level waste tanks, contaminant plumes, landfills, mixed waste, and facility decommissioning and decontamination. In addition, EM has recently chartered a sixth focus area -- plutonium stabilization and immobilization. While this focus-area approach is still maturing, it provides a necessary link between technology developers and technology users and allows innovative research and development from national laboratories, universities, and industry to be used more effectively.

- EM established an Environmental Management Science Program in FY 1996 for targeted, long-term basic science research to reduce cleanup costs and risks to workers and the public. Consistent with the recommendations of the NAS and others, including Congress, EM is developing a Science Program to bridge the gap between broad, fundamental research, such as that performed in DOE's Office of Energy Research research programs, and the needs-driven applied technology development conducted in EM. The NAS and the EMAB will provide independent, external views of the program's science needs, to evaluate the relative merit of meeting these needs through science, and to provide a framework for performance measures.

- EM has identified barriers to innovative technology and has developed an innovative acquisition strategy. Within current Federal Acquisition Regulations and the Department of Energy Acquisition Regulations, EM has the ability to use phased contracts that move from applied concept feasibility through full-scale demonstration, without recompetition. To do so, contracts will require well-defined decision points between phases of work. Phasing of contracts is occurring from development to demonstration.

  In FY 1995, allocation of research and development funds across technology developers was as follows: 59 percent to national laboratories and production facilities, 30 percent to industry, 10 percent to universities, and 1 percent to interagency agreements. EM is seeking to increase the percentage of science and technology funds sent outside the DOE system.

- EM has strengthened the peer review process for technology development and selection. In 1994, EM strengthened its peer review process to include the environmental science community more fully. As part of this process, the NAS Board on Radioactive Waste Management, the Committee on Environmental Management Technologies, the EMAB, and the SSABs provide peer review. Focus area review groups, convened by the NAS, conduct program-level reviews that include individuals from outside of the Department. Each focus area and cross-cutting technology program has developed external peer review processes for review of technology procurements as well as technical program reviews. Site Technology Coordination Groups, which include technology developers, site technology users, and external stakeholders, provide more technical reviews at the project level. Major review criteria for making technology development and selection decisions include: technical and scientific merit; effectiveness in contributing to national needs; the technical potential of an approach or its successful demonstration; potential for risk reduction and safety improvements; cost-effectiveness; regulatory and public acceptability; and potential for technology transfer and commercialization. EM selects lead field organizations and laboratories for new focus areas through a competitive selection process.

- EM invites industry and academia to work on technology and science issues through competitive solicitations that have had external peer review. DOE communicates business opportunities through a number of vehicles, including EM's 1-800 telephone number, the *Commerce Business Daily*, the *Federal Register*, and professional meetings. The Environmental Management Science Program has issued a competitive solicitation for science research projects and expects to make selections and awards in FY 1996. These selections are to be externally peer reviewed, with awards made to federal laboratories, academic institutions, and private industry.

- EM has improved links between technology developers and users. At a meeting of senior managers from the field and Headquarters in January 1996, EM technology developers and technology users formally agreed to work together to eliminate remaining hurdles to deploying promising and innovative technologies that have been successfully demonstrated. The goal is the routine participation of technology developers and site technology users in joint program planning and budgeting, as well as program implementation and evaluation

ACTIVITIES FOR FURTHER PROGRESS:

- EM will improve and streamline the procurement process to encourage use of innovative technologies. EM senior managers will modify appropriate contracts to become performance-based using predetermined specifications. Specifications that are essential to this performance-based strategy include. (1) identification of final waste forms; (2) use of business terms and conditions; (3) progressive approaches to indemnification for cleanup activities; (4) streamlined regulatory acceptance; and (5) use of a consistent cost framework. Rather than focusing on process, EM will emphasize product as a final waste form. EM will consider a range of possibilities and select the innovative technological system or technology that best meets the predetermined performance-based specifications at the lowest cost and least risk.

- In the spring of 1996, EM will design and implement the new strategic basic research program through the EM Science Program. As directed by Congress, EM has solicited applications for FY 1996 grants in cooperation with the Office of Energy Research. By the fourth quarter of FY 1996, EM will award FY 1996 grants, develop metrics and communication tools, and work with internal and external stakeholders to develop the most relevant program for FY 1997.

- EM will monitor and improve the peer review process. EM will assess groups of peers to ensure the inclusion of representatives from four different areas: (1) recognized technical experts; (2) federal and contractor users who establish performance criteria for technologies; (3) stakeholders knowledgeable about non-technical criteria; and (4) regulators who understand the relationship between technical and non-technical criteria and regulatory requirements. EM intends to continue to strengthen its peer review process.

- EM will accelerate commercialization of technologies. As a partner in the interstate and interagency Rapid Commercialization Initiative, EM will help firms overcome such barriers as a lack of test beds for full-scale technology demonstrations and a lack of credible technology verification procedures. It will encourage multistate participation to facilitate interstate cooperation for faster permitting. As part of this initiative, EM is working with the California Environmental Protection Agency, Western Governors' Association Interstate Technology and Regulatory Coordination Group, Southern States Energy Board, and EPA to streamline regulatory requirements and encourage additional states to participate in technology demonstrations. EM will use lessons learned in this effort to develop improved technology policies to foster better industry, state, and federal cooperation and collaboration. Project selections, based on a competitive process, including merit review, were announced in mid-March 1996. Demonstrations and technology verification will follow. DOE's goal is to develop a standard test protocol for the contaminated plumes focus area and the characterization, monitoring, and sensors program through the Rapid Commercialization Initiative.

2.4 Implement a Charge-back System For Waste Management Services

The NAS and others, including the EMAB, have identified a fundamental disincentive within the Department: programs that generate waste do not budget for the management and disposal of that waste. Instead, EM provides the service and funding for their waste treatment, storage, and/or disposal. Both the NAS and the EMAB have recommended that waste generators pay for the costs of handling the waste they generate. NAS states a "life-cycle approach to ensure that environmental consideration is given to all processes and products, with a goal of eliminating or drastically reducing waste streams at every stage of activity... Programs and operational groups should be expected to pay for the waste they generate." (p. 107-108)

EM has recognized the need for generators to "internalize" the full life-cycle costs of waste management into both their long-term strategic as well as daily management decisionmaking. Internalizing costs that are external to the decision to generate certain quantities of waste includes the concept of a charge-back system, in which waste management costs are "charged back" to generators.

ACCOMPLISHMENTS TO DATE:

- EM has reviewed waste minimization and management performance at selected sites. The EM Waste Management Alternatives Working Group conducted a cross-site review and has drafted a report that contains recommendations that are similar to the NAS report. According to this Working Group, the Department should:

- Re-engineer the waste management program to reduce overall costs;
- Re-configure responsibility for waste management to place accountability on the organizations that generate waste for the costs of the waste they generate; and therefore,
- Reduce the quantities of radioactive and hazardous waste being generated.

The Working Group identified four options to recalibrate waste management costs, responsibilities, and waste volumes. The options vary in the degree of responsibility that the EM Waste Management program would assume, from administering all waste management activities complex-wide and instituting cost-cutting reforms, to charging a fee for waste processed, to turning over all waste management functions to the generating organizations. EM will select one of these or some combination of these options, taking into consideration site-specific characteristics.

- Sites are already implementing a partial "charge-back" system. The low-level waste charge-back program at the Nevada Test Site (NTS), for example, includes all approved generators that dispose of waste at the site: EM programs, the DOE Office of Defense Programs, and external organizations, such as Department of Defense, and other agencies. Fees collected through the "charge-back" system are used to fund approximately 50 percent of activities directly related to the handling and disposal of the waste received. The NTS charge-back system and a similar system at the Hanford Site are described as partial in that neither captures the true life-cycle costs that DOE and ultimately the U.S. taxpayers fund. These systems capture a relatively small share of the total DOE waste management costs.

- EM has implemented a pilot program for generator set-aside fees. The EM Office of Pollution Prevention has implemented a "generator set-aside"program under which generators at the Savannah River Site, Oak Ridge, Los Alamos National Laboratory, and Sandia National Laboratories are charged between one and five percent of the estimated waste management costs. The goal of the program is to determine the merits and practicality of assessing waste generating organizations a fee based on the type and quantity of their waste and to provide funds from the set-aside fees for implementing pollution prevention activities. Oak Ridge will have all its waste streams included in the charge-back program by the end of this fiscal year.

ACTIVITIES FOR FURTHER PROGRESS:

- The Waste Management Alternative Working Group will soon issue recommendations on improving performance in the EM Waste Management program by driving down operating costs and providing incentives for pollution prevention. These cost-cutting initiatives are, in most cases, already being implemented and would continue to be implemented by the Waste Management program. The Working Group report further notes that generators should take on greater responsibility for treatment, storage, and disposal of waste. EM will make a final decision on future management and financial responsibility of the treatment, storage, and disposal of waste by September 1996.

- EM will implement a full cost recovery system. The infrastructure for implementing a full cost recovery or "charge-back" system will be better understood when the results from the pilot system are available. EM is currently estimating activity-based costs for waste management so that the full cost recovery system might be implemented across the complex as early as FY 1999. The Savannah River Site is planning to implement such a program in FY 1997.

2.5 Work Collaboratively with States and EPA to Establish a Lead Regulator and to Improve Regulatory Flexibility

The large number of agencies with oversight and regulatory authority over EM activities has adversely impacted efforts to cleanup environmental contamination at certain sites, according to the NAS. In addition, lack of knowledge about regulatory flexibility and communication with regulators has, at times, precluded the identification of alternative, less costly, and mutually acceptable compliance approaches. To streamline the regulatory process and avoid costly disputes and delays at sites where a unified, coordinated plan of action does not exist, the NAS recommends that all relevant regulatory and oversight agencies should designate a lead regulator responsible for overseeing the cleanup.process on a daily basis. "If more than one regulatory entity, including state and federal agencies, has jurisdiction over a Department site, a lead regulator should be designated for a cleanup activity or group of cleanup activities and every effort should be made to have as few different regulators at a site as possible," notes the NAS. (p. 23)

Other streamlining options might include early stakeholder involvement; seeking cleanup under the Resource Conservation and Recovery Act (RCRA) rather than the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA); use of a one-document approach when invoking RCRA and CERCLA; training personnel and contractors on the National Environmental Policy Act (NEPA), CERCLA, and RCRA; and possible delegation of CERCLA authority to states.

ACCOMPLISHMENTS TO DATE:

- DOE is participating in the EPA Lead Regulator Group. In 1995, EPA established an interagency group to reach agreement on reforms to RCRA and CERCLA cleanup programs. The work group includes representatives from states, the Association of State and Territorial Solid Waste Managers Organization, DOE, the Department of Defense, the Department of Agriculture, the Department of the Interior, and the Department of Justice. The main goal of the RCRA/CERCLA lead regulator work group is to develop policy to prevent duplication in cleanup procedures, documentation, requirements, and regulator oversight of federal facilities on the National Priorities List. In this approach, a lead regulatory agency would assume primary responsibility for oversight at a site. Facility cleanup procedures, requirements and documentation would follow one cleanup program, with the minimum requirements of the other program factored into the process.

- Many DOE facilities have signed Federal Facilities Agreements or are negotiating "tri-party" or "bi-party" agreements for addressing environmental management activities. For example, the Hanford Site has reached agreement with the State of Washington and with EPA to divide responsibilities at the Hanford facility, designating a single regulator for each operable unit. DOE and the regulators developed this process with stakeholder participation and concurrence, and stakeholders and regulators continue to be involved in budgets and projects. RCRA and CERCLA integration is included in the compliance agreement. The decommissioning process adopted in the Tri-Party Agreement also minimizes the number of documents required to satisfy multiple requirements under RCRA, CERCLA, and the Atomic Energy Act (AEA). In addition, the Rocky Flats Environmental Technology Site has developed an agreement with the EPA, the State of Colorado, and the Defense Nuclear Facilities Safety Board that embodies this concept of a lead regulator.

ACTIVITIES FOR FURTHER PROGRESS:

- EM will encourage interested states with DOE sites to become involved in the EPA Lead Regulator Work Group. EM will continue to work with EPA on the Work Group and to involve other states in this process to develop policy guidance on the lead regulator approach. EPA intends to issue guidance to their regions in July 1996 on implementing the lead regulator concept. DOE will also continue to use its work-out sessions to identify lead regulators for its sites with existing compliance agreements and to work with the states and EPA to incorporate the lead regulator concept into new agreements.

- EM will evaluate NEPA and RCRA policies and integration. EM will form a task team to make recommendations on possible future strategies to extend the Secretarial policy on NEPA and CERCLA to include RCRA corrective actions. EM expects to develop a draft strategy with stakeholder input by the fall of 1996, which will include recommendations and a schedule for actions to resolve issues.

  The task team will focus on the functional equivalence of RCRA corrective action requirements to NEPA, where RCRA applies, and it will seek to identify ways to streamline the RCRA and NEPA processes, as NEPA and CERCLA have been integrated as functionally equivalent where CERCLA fulfills NEPA.

- EM will work across sites to identify more flexible options within the existing regulatory framework. By creating a partnership between DOE and its regulators at select sites (e.g., Hanford), DOE and the regulators will work collaboratively to identify means to accelerate cleanup and reduce compliance costs. Such a program, patterned after a successful Navy-led program with EPA and states, is planned for the tank waste remediation system at Hanford and has been initiated for the Hanford 100 Area cleanup. DOE will continue to use "work-out" sessions as a means to identify opportunities to create a more cost-effective compliance process. EPA's forthcoming guidance on lead regulator approaches will also provide a framework for streamlining and integrating cleanup requirements, ultimately resulting in more timely and cost-effective cleanups.

3. Conclusion

The NAS has concluded that although EM needs to continue to improve in many areas, it is moving in the right direction and has made significant progress. The NAS recommendations provide an opportunity for EM to take the next steps toward better management and more results. In this response, EM has committed to making immediate progress in the following five major areas:

(1) Developing a system that rewards performance and increases accountability;
(2) Establishing a more consistent priority-setting process to be reflected in the budget;
(3) Focusing environmental science and technology development on EM's needs, ensuring science and technology selections are competitive and peer-reviewed, and ensuring basic research is targeted to technology needs;
(4) Implementing a charge-back system for waste management services; and
(5) Working collaboratively with states and the U.S. Environmental Protection Agency (EPA) to establish a lead regulator and to improve regulatory flexibility.

EM's goal is to implement many of the specific activities described above by the end of FY 1997. In the continued spirit of encouraging stakeholders to assist the program move forward, the Assistant Secretary has requested that the EMAB evaluate EM's progress in reaching these goals. EM will provide a progress report on the activities presented in this response to the Assistant Secretary and to the EMAB by the end of 1996. The EMAB will provide its assessment to the Assistant Secretary by the end of March 1997.

APPENDIX 1
RECOMMENDATIONS, ACCOMPLISHMENTS, AND FUTURE ACTIONS

NAS Recommendation	Examples of Accomplishments to Date	Future Actions	Responsible Organization
Develop a system that rewards perfarmance and increases accauntability	(1) Clarifying goals and expectations of the programs and sites (e.g., revising EM Strategic Plan to clarify program mission, set the vision for the program, and define specific goals and objectives).	(1) Develop an integrated management plan through the newly established Process Improvement Team.	EM-30, -10, -20, -40, -50, -60, -70
	(2) Developed the "Critical Few" performance measures.	(2) Reward progress at sites through performance recognition allocations.	EM-10, -20, -30, -40, -50, -60, -70
	(3) Conducted several "benchmarking" efforts with external partners, including other federal agencies and private industries.	(3) Continue to expand contracting reform efforts broadly across the program.	EM-15
	(4) Renegotiating and recompeting contracts to reward performance.	(4) Explore the development of a pilot program and incentives to reward employees for outstanding performance.	EM-10
	(5) Using reporting and feedback mechanisms to improve the overall program management	(5) Use benchmarking and other methods to reduce costs.	EM-13, -30, -40, -60, -74
	(6) Continuing "work-out" sessions in which Headquarters, field and contractor managers and senior representatives of Federal and state regulatory agencies find more cost-effective ways to meet mutual environmental goals.	(6) Encourage creative management approaches through effective training.	EM-10

NAS Recommendation	Examples of Accomplishments to Date	Future Actions	Responsible Organization
Establish a more consistent priority-setting process to be reflected in the budget	(1) Including risk reduction, "mortgage reduction," compliance, and stakeholder concerns in budget formulation priority-setting. (2) Continuing to balance local and national goals in the budget process. (3) Involving stakeholders in the budget process. (4) Using external peer review to refine risk data and other information for budget formulation.	(1) Establish more clearly stated cleanup goals through strategic planning, future land-use efforts and other initiatives. (2) Expand annual lessons-learned meetings to discuss how to improve priority setting in the budget process and the effectiveness of involving stakeholders at each site. (3) Develop uniform definitions of "activity" across the complex to allow for more accurate site and program comparisons (to avoid inappropriate "bundling").	EM-20, -74, -75, sites EM-23, -30, -40, -50, -60, -70, sites EM-23, -52, -74, -30, -40, -60, sites
Focus environmental science and technology development an EM's needs, ensure science and technology selections are competitive and peer-reviewed, and ensure basic research is targeted to technology needs	(1) Established and adapting focus areas to meet EM's needs. (2) Established an Environmental Management Science Program for targeted, long-term basic science research to reduce cleanup costs and risks to workers and the public. (3) Identified barriers to innovative technology and developed an innovative acquisition strategy. (4) Strengthened peer review process for technology development and selection. (5) Invites industry and academia to work on technology and science issues through competitive solicitations that have had external peer review. (6) Improved links between technology users and technology developers.	(1) Improve and streamline the procurement process to encourage use of innovative technologies. (2) Design and implement the new strategic basic research program through the EM Science Program. (3) Monitor and improve the peer review process. (4) Accelerate commercialization of technologies.	EM-50, -10, sites EM-52 EM-50 EM-50, -30

NAS Recommendation	Examples of Accomplishments to Date	Future Actions	Responsible Organization
Implement a charge-back system for waste management services	(1) Reviewed waste minimization and management performance at selected sites. (2) Implemented partial "charge-back" systems at some sites. (3) Implemented a pilot program for generator set-aside fees at some sites.	(1) Issue recommendations on improving performance in the EM Waste Management program by driving down operating costs and providing incentives for pollution prevention. (2) Begin implementing a full cost recovery system.	EM-77, -30, sites EM-77, -30
Work collaboratively with states and EPA to establish a lead regulator and to improve regulatory flexibility	(1) Participating in the EPA Lead Regulator Work Group to develop policies on a lead regulator approach (2) Signed Federal Facilities Agreements or are negotiating "tri- party" or "bi-party" agreements to address environmental management activities	(1) Encourage interested states with DOE sites to become involved in the EPA Lead Regulator Work Group. (2) Evaluate NEPA & RCRA policies and integration. (3) Work across sites to identify more flexible options within the existing regulatory framework.	EM-75, -30, -40 EM-75, -30, -40 EM-75, -30, -40

Q4. **On page 9 of your prepared testimony, you stated that "we have integrated information about risks to public health, worker safety, and the environment into the Fiscal Year 1998 budget formulation process".**

Please elaborate on this and how it will be a change from past budget formulation exercises.

A4. The Fiscal Year 1997 Environmental Management budget was the first to consider risks in setting funding priorities. In formulating the FY 1998 budget risk again was an important consideration. Building on the experience gained on the 1997 budget process and the Environmental Management Advisory Board Risk Committees' budget process recommendations EM developed "Management Evaluation Matrix" as a tool in scoring activities. Sites were to address the relative risk of current conditions (before the activities are performed) and the relative impact expected to remain (after the activities are completed). The resulting scoring information was then used in the priority setting processes.

In addition, the FY 1998 Budget Formulation Guidance directed the EM field offices to fully consider the impact of several key factors in developing the FY 1998 budget–namely, risk, cost effectiveness, compliance requirements, and stakeholder concerns. The sites were required to show what the priorities would be if a specific factor was the controlling consideration. The result was five separate priority lists for each site–one for each of the four factors noted above as well as an "optimized" list that balanced all four factors.

This analysis and consideration of risks was more rigorous than in previous budgets. Additionally, at the Department's request, an external group, the Consortium for Risk Evaluation and Stakeholder Participation (CRESP), peer reviewed both the information and process used to formulate the FY 1998 budget.

Q5. **On page 11 of your prepared testimony, you stated that "we have changed the way characterization studies and site assessments are handled in the contracts, so that emphasis is placed on doing the actual work, not simply studying the problem." Please elaborate on this statement.**

A5. The Environmental Management (EM) program is emphasizing completion of cleanups by including remediation performance measures in annual program execution agreements with the field. As indicated in EM's FY 1997 budget submission, the Environmental Restoration program is allocating more and more funding to actual cleanup efforts and completing needed characterization activities as soon as possible so remediation can begin, if needed.

Initial site survey and sample plans have been drafted with regulator and stakeholder support so that the assessment work now encompasses minimally required sampling and surveying. We've also been able to get support on reducing the amount of written reports that document findings at the sites during the assessment phase. In many cases, site-wide investigations have replaced individual operable unit or released site assessments, which has saved time and money. Where immediate cleanup attention is required to alleviate risk (control of contaminated groundwater plumes or other needed near-term cleanup), interim actions have been approved by the regulators and implemented by the Department. The interim action process and implementation has replaced in some cases more long term, costly solutions that may have been initially planned as the remedial solution. EM has also pursued interim actions and removal actions with the idea of coming to a "no further action" decision early in the assessment process. In some cases, this has eliminated the need for Feasibility Studies. These are some of the ways EM has changed the way characterization and site assessments were carried out in the past.

At Hanford, examples of changes to field agreements and contracts include the use of performance measures and performance objective criteria in the award fee which are related to completion of work, not characterization.

At Sandia National Laboratory and Los Alamos National Laboratory, provisions were negotiated and included in the contracts, specifying as a performance measure that at least 60 percent of the work conducted be directed toward remediation, with the balance toward characterization studies. In addition, actual numbers of remediations and assessments expected to be performed during the contract period are included as performance metrics.

At Idaho, there are at least two examples of how we have placed a greater emphasis on doing actual cleanup work rather than assessment. First, EM has instituted a response action procedure which allows for interim cleanup of sites under its CERCLA/RCRA the Federal Facility Agreement with EPA and the State of Idaho. This also allows EM to obtain a determination of "No Further Action" under the Track One or Track Two provision of the agreement. EM can then concentrate cleanup efforts on known areas of contamination and eliminate characterization and assessment activities for the "No Further Action" sites and sites requiring further action, but where adequate characterization data exists. Secondly, the contract with the Management and Operating contractor specifies that in FY 1996, the annual award fee be 40% for performance and 60% incentive award, and be changed over the next three remaining years to 80% performance award and 20% incentive award. The contract also requires that the cleanup of the Idaho National Engineering Laboratory site be accelerated by nine years with completion projected in the year 2010. This would reduce the cost by approximately 20% and accelerate the removal of the site from the National Priorities List.

Lastly, in FY 1995, a new performance-based incentive fee contract was awarded for the integrated management and cleanup of the Rocky Flats Environmental Technology Site in Colorado. Performance measures are negotiated annually with the contractor for all services rendered, establishing milestones, which must be substantially met to receive payment in lieu of a contract award fee. This allows the site to prioritize and incentives cleanup work with an emphasis on interim and accelerated actions in stabilization, deactivation, decommissioning, and remediation.

More and more progress will be achieved in the future as EM continues to emphasize performance and completion of cleanup as soon as possible.

Q6. **At the bottom of page 13 of your prepared testimony, you stated:**

"Since its inception, the technology development program has developed a portfolio of 170 new or improved technologies. An ongoing review of 37 of these new technologies revealed that, depending upon the degree of cleanup, at least $15 billion and as much as $20 billion could potentially be saved through the use of just these 37 processes."

Who conducted this review and what are the analytical bases for these claims?

A6. Item "a" below states who conducted the review and item "b" provides the analytical bases.

a. Technical staff members of the Department of Energy's Environmental Management Program's Office of Science and Technology (OST) and their support from the OST Focus Areas, Crosscut Programs, support contractors, and national laboratories conducted this review.

b. The projected savings are potential life cycle cost savings based upon the future utilization of emerging technologies from one decade of effort, i.e., the years 1990 to 1999. The analytical bases for the claimed savings are as follows for each step in the cost savings analysis:

1) **Selecting the technologies:** The Focus Area and Crosscut Programs selected the technology systems based upon two criteria: (1) that a large cost savings could be achieved by substituting an emerging technology system for a baseline system, and (2) that sufficient cost and performance data be available for a credible estimate to be made.

2) **Estimating the potential life cycle cost savings per unit volume of waste:** Cost and performance data was obtained from the Focus Areas and Crosscut Programs for each emerging technology system evaluated. The cost methodology used for each system was relatively standard and uniform, including costs for construction, operation, and maintenance of a full scale plant of a certain capacity, so that the cost per unit volume of waste could be obtained. The equivalent cost per unit volume of waste for a conventional or baseline system was obtained. The difference between the two was the potential cost savings per unit volume of waste possible by using the emerging technology system.

3) **Estimating the maximum potential life cycle cost savings by implementing a technology system across the DOE Complex:** The applicability of each technology system to waste streams, sites, or facilities

across the DOE Complex was determined based upon data submitted by DOE Field Offices for or define the 1996 Baseline Environmental Management Report (BEMR). These data stated the volume of wastes and projected cost of cleanup using baseline systems for specific waste streams, facilities, and sites across the Complex. Engineering judgment was used to determine whether an emerging system could be substituted for a baseline to remedy a specific cleanup problem, and the total of all substitutions for each technology system was tallied, yielding the maximum potential life cycle cost savings for that system. This was reduced as discussed below. Note that the maximum potential savings depends upon the cleanup scenario, as do all other potential savings discussed below.

4) **Estimating the reduced potential life cycle cost savings per technology system:** Three reduction factors were used: (1) the incompleteness of available technical data on the emerging technology system, (2) the uncertainty in the system's regulatory acceptance; and (3) any barriers to use because of institutional commitments to other approaches. For each factor, the maximum savings was reduced by a percentage, which increased proportionally with the severity of concern. For the most part, these reductions were in the 10% to 30% range, and the reduced life cycle potential cost savings for each technology system ranged from zero to over half the maximum.

5) **Estimating the aggregate reported potential life cycle cost savings:** The reduced cost savings for each technology system was tallied to yield the aggregate reported potential life cycle cost. Industrial experience indicated that about one third of the products which proceed into advanced development ultimately result in new technologies. OST supports a total of about 170 technologies in Fiscal Year 1996, and cost reduction is a driver for 120. We would expect approximately 40 technology systems to be successfully implemented from this portfolio, based upon industrial experience. Should any one of the 37 technologies evaluated not be used, it is likely that one of the remaining 120 technologies will be used. Therefore, the aggregate reported potential life cycle cost savings of $15 to $20 billion is considered to be more accurate than the potential savings for any one technology.

6) **Investment cost in OST to achieve the reported potential savings:** The reported potential savings requires an investment in the OST. This investment is taken in the years 1990 to 1999, for which the total OST budget for technology development is projected to be $3 billion.

Q7. The Executive Summary of the recent National Research Council report by the Committee on Environmental Management Technologies (CEMT), *Environmental Management Technology-Development Program at the Department of Energy: FY 1995 Review* states the following:

> **". . . During the past year, . . . DOE-EM has only made limited progress in implementing the recommendations of the committee's first-year report (NRC, 1995). A great deal more needs to be done before DOE-EM has a vital, focused, and coordinated technology-development program sufficient to support the technically and organizationally complex waste-remediation program effectively . ." (Page 1).**
>
> **". . . CEMT believes that major improvements are needed in the fundamental management process if the EM research and technology-development program is to meet its responsibilities to the DOE and the public. . ." (Page 2).**

What is your response?

A7. A formal response to the Committee on Environmental Management Technologies was sent to the NRC in June. A copy of that response is attached. The NRC agrees with the responses and has indicated that the Office of Science and Technology (OST) is making progress toward resolving the issues identified in the Committee's first year report.

In the response to the NRC, OST clarified that, since the major reorganization of the Office of Technology Development [now called the Office of Science and Technology (OST)] in 1994 into field-managed technology Focus Areas, EM has completely revamped its research and technology development program management to address the issues that were raised by the CEMT and in a previous report by the GAO entitled "Cleanup Technology - Better Management for DOE's Technology Development Program," GAO Report GAO/RCED-92-145, April 1992. Issues included the reorganization of a large and diverse program into an integrated "EM Team" organization that focuses on major problems at DOE sites and has representatives from other EM offices and field offices.

OST has become an organization that is focused on site specific needs, in cooperation with the site operations personnel who are responsible for the cleanup. The priority setting of project funding and program direction is now conducted with input from user sites and stakeholder. Site teams, called Site Technology Coordination Groups (STCGs), have been formed at each major site and are producing the site needs assessments, which are used to drive the technology development program. To maintain a high level of confidence in this program, EM has adopted a systems approach to identify deficiencies within a remediation process and for evaluating technologies. The operating philosophy within the OST Program is to form open partnerships between the national (public and private) science and engineering communities, industry, academia, government agencies, other countries and the public. To keep tight financial control over the program, a compilation of Cost/Performance Variance Analysis (C/PVA) reports is compiled and distributed throughout OST on a monthly basis. The C/PVA gives information on cost/schedule variances, performance indices, carryover projections, and provides accurate trend analysis for management review and action.

These changes and many others have transformed OST by focusing the program on specific cleanup needs in a partnership with stakeholders, regulators and industry. This partnership insures that the final products of this program are implemented at the sites to reduce costs, reduce risk and achieve site cleanup.

DOE/EM Office of Science and Technology Response to National Research Council Report:

"Environmental Management Technology Development Program at the Department of Energy-1995 Review"

June 13, 1996

Prepared by:

U.S. Department of Energy
Office of Environmental Management
Office of Science and Technology

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DOE/EM OFFICE OF SCIENCE AND TECHNOLOGY RESPONSE TO THE NATIONAL RESEARCH COUNCIL REPORT:

"Environmental Management Technology Development Program at the Department of Energy - 1995 Review"

I. Preface

In response to the National Research Council (NRC) Committee on Environmental Technology Management (CEMT) report, "Environmental Management Technology Development Program at the Department of Energy - 1995 Review," the Department of Energy (DOE), Office of Environmental Management (EM), Office of Science and Technology (OST) (formerly known as the Office of Technology Development) has prepared this document to clarify past and ongoing activities related to the NRC's recommendations.

The Program has made progress since its reorganization in 1994 into focus areas and has already considered many of the recommendations submitted by the CEMT. The OST not only agrees with many recommendations of the CEMT, but had already implemented many of these suggestions before the publication of this study. It should be noted that many of the CEMT recommendations were identified by the U.S. General Accounting Office (GAO) in an earlier review of the OST and were acted upon as early as 1992. [1] It should also be noted that there is a difference between the OST Program and the technology development activity throughout EM. Many of the recommendations made by the CEMT are not clear as to whether they refer to the general technology development activity or the OST Program. This and other inconsistencies throughout the report bring confusion to this review of the OST program.

Since the creation of the "New Approach to Environmental Technology Development at DOE" in 1993, the Technology Development (TD) Program has adjusted its technology approach and pursued new initiatives to best satisfy the Department's cleanup needs.[2] The 1994 reorganization of such a large and diverse program into an integrated "EM Team" organization that focuses on major problems at DOE sites and has representatives from other EM offices and field offices in its guidance, was a monumental task. Many NRC recommendations have already been implemented and are yielding valuable results. However, it should be noted, some of the recommendations are outside the control of the OST Program; they are an issue for EM as a whole. Examples include the collection and distribution of site problem characterization data and the priority ranking of the environmental remediation problems at each site. EM is addressing such issues through the Site Technology Coordination Groups (STCGs). However, until complex-wide site characterization data are available and the risk priority ranking process is completed, the OST cannot meet the expectations set by the CEMT recommendations.

II. Introduction

The DOE Office of Environmental Management (EM) was established in November 1989 and tasked with cleaning up the legacy of environmental pollution at DOE weapons complex facilities nationwide, preventing further environmental contamination, and instituting responsible environmental waste management and restoration.[3] It has become apparent that the magnitude and complexity of many aspects of this mission are such that it cannot be achieved using existing technology without incurring unreasonable cost, risk, or schedule impact; and, in some cases, there are no known methods by which to clean up the contamination.[2] To this end, the OST conducts an aggressive national research and development program responsible for the demonstration, testing and evaluation of new and innovative technologies which meet EM needs in five major focus (or problem) areas, including:

- **Contaminant Plumes Containment and Remediation:** addresses uncontained hazardous and radioactive contaminants in soil and groundwater.*
- **Landfill Stabilization:** addresses the migration and remediation challenges posed by DOE landfills.*
- **High-Level Tank Waste Remediation:** addresses the large number of storage tanks containing over 100 million gallons of radioactive waste.
- **Mixed Waste Characterization, Treatment, and Disposal:** addresses treatment and disposal of hazardous waste with low-level and transuranic radioactivity contamination.
- **Decontamination and Decommissioning:** addresses the need to transition, decommission, deactivate, and dispose of aging and contaminated DOE weapons complex facilities.

* These have recently been combined to a **Subsurface Contaminants Focus Area.**

Crosscutting programs that support all Focus Areas include:

- **Science Program:** provides a fundamental science basis for innovative technologies to allow optimization of current demonstrations and to stimulate the development of breakthrough technologies.
- **Characterization, Monitoring and Sensor Technology:** develops systems to accurately characterize, monitor, and analyze wastes.
- **Efficient Separations:** develops technologies to extract radionuclides and other toxins to save disposal costs by reducing waste volume.
- **Robotics:** reduces worker risk and makes certain tasks possible by using remotely controlled robotic systems.
- **Technology Integration:** involves critical external entities (sites, users, public, tribes,

regulators, private industry, universities) to ensure that innovative technical solutions are acceptable and commercially available.
- **Industry and University Programs:** ensures private industry and university participation in developing and implementing innovative technologies through Program Research and Development Agreements (PRDAs) and Research Opportunity Announcements (ROAs).

The operating philosophy within the OST Program is to form open partnerships between the national (public and private) science and engineering communities, and industry, academia, other government agencies, and other countries. This approach brings the best scientific and technical skills to a problem, ensures that the solution meets an EM need and provides leveraged funds for the program, i.e., Remediation Technology Development Forum (RTDF) Bioconsortium.[4] The use of partnerships allows the program to leverage its resources against its partner's resources, reducing duplication of efforts between individual federal agencies and the private sector. The partnership philosophy also fosters the use of the life-cycle systems approach to each solution by inviting experts from all aspects of the problem, including stakeholders and regulators, to participate.

The focused approach requires the participation of the experts at the sites to help determine the priority of the health and environmental risk-reduction needs at those sites. It is the objective of OST to rely on sites themselves to rank the needs in priority order based on technical and stakeholder input. Site teams, called Site Technology Coordination Groups (STCGs), have been formed at each major site and are producing the site needs assessments in an orderly format that can be used to drive the technology development program.[2] It is expected that these groups will be able to work with the local stakeholders, regulators and technology developers to establish final waste form requirements, environmental endpoints, and time frames for the introduction of new technologies into the remediation schedules. An example of a successful STCG is the one which has been formed at the Richland Operations Office.[5]

To maintain a high level of confidence in its TD Program, EM has adopted a systems approach to identify deficiencies within a remediation process and for evaluating technologies.[6] This approach first establishes the baseline remediation scenarios, then critically analyzes them for opportunities to reduce cost and human/environmental risk, and to expedite the cleanup process. Emerging technologies are matched to the deficiencies and monitored as they advance through successive development decision points. External, qualified independent peer reviews evaluate programs and projects, integrating activities across EM to create a national program.

The application of the life-cycle systems approach to the resolution of environmental problems is not a new concept within the OST. The evolution of this approach is indicated in numerous documents generated in the early years of this organization. In testimony, the General Accounting Office stated that "DOE also developed an initial strategy to support each major R&D area with integrated demonstrations." An integrated demonstration tests multiple technologies at a particular DOE site and ultimately delivers an entire system to address a specific cleanup problem at this site. A total system includes site characterization, remediation, and monitoring technologies. The evolution of the technological systems and the appropriate organizational structure has been apparent over the six years of existence of the TD Program.[7] Continual involvement of regulators and stakeholders (national and local) is fostered in order to enhance acceptable, innovative solutions.

Within EM, the OST Program has been a leader in the application of business management practices to control projects. On a monthly basis, a compilation of Cost/Performance Variance Analysis (C/PVA) reports is distributed to OST's Deputy Assistant Secretary (DAS), the Associate Deputy Assistant Secretary for Technology Development (ADAS), focus area teams, program managers, and operation offices. Each C/PVA is a concise report on all activities related to OST at its lowest level, i.e. Work Breakdown Structure (WBS) level, and is summarized at the focus area, program, and OST level. The C/PVA gives information on cost/schedule variances, performance indices, carryover projections, and provides accurate trend analysis for management review/action. The C/PVA is supplemented by OSTs Monthly Business Review. At this review, the focus area and program managers present their programs to the DAS and the ADAS. Again, managerial and financial control is the focus, with corrective action plans if needed, as well as any issues, concerns, or problems. The methodology used is earned-value analysis for management decision. The earned value analysis method enables OST to streamline its business processes to save time, resources, and costs.[8]

Quantitative measures of FY95 Program performance [9] are as follows:

- Demonstrated more than fifty (50) new or improved technologies/systems.
- Twenty-four (24) new technologies/systems were made available to the sites for implementation.
- Directed forty-one percent (41%) of the technology development budget to the private sector.

In addition, a number of EM Technology Development's industry partners have commercialized innovative environmental management technologies.[10] A qualitative, yet tangible, mark of accomplishment is the receipt of six "R&D 100" awards from *R&D Magazine* for Technology Development funded technologies. Innovative and improved technologies and systems have significantly reduced costs, schedules, and risks in EM operations across the DOE complex.[11] Many alternatives or improvements to baseline technologies have been demonstrated and verified to meet users' and stakeholders' critical-decision criteria, regulatory requirements, and timetables.[12,13] Market-driven activities are being established to support ongoing implementation of innovative solutions through privatization initiatives.[12,13]

During the past year, many new initiatives and program direction changes have occurred in the TD Program. A representative sample of these changes includes:

- Reorganized Headquarters to streamline policy development and program direction.
- Established a science and risk component to develop a basic science agenda for environmental management.
- Further decentralized project management to the field:
  - Mixed Waste Focus Area - Idaho
  - Tank Focus Area - Richland
  - Subsurface Contamination Focus Area - Savannah River
  - D&D Focus Area - Morgantown
  - Robotics Crosscut - Albuquerque
  - Characterization Crosscut - Nevada
  - Technology Evaluation/Screening - Oak Ridge
- Established a "Board of Directors" concept involving the Operations Office Managers to shift the ownership of the program to the Operations Offices and ensure greater user involvement and implementation of the technologies at DOE sites. This has reduced the "field vs. headquarters syndrome," which has been identified as a problem in previous reports.[14-15] The five Board of Directors members are:
  - Deputy Assistant Secretary for Science and Technology
  - Manager - Richland Field Office
  - Manager - Idaho Field Office
  - Manager - Savannah River Field Office
  - Manager - Morgantown Energy Technology Center
- Established "Process Improvement Teams" for:
  - Standardized priority ranking system for needs leading to the formulation of the EM overall and focus areas R&D investment strategies
  - Performance measures
  - Technology implementation
  - Budget Development
- Expanded "Systems Engineering" activities to address waste stream/waste form

specification issues in needs assessment process.

- Standardized the technology evaluation and screening process.
- Documented technology performance through a standardized engineering document.
- Consolidated the “Landfills” and “Plumes” Focus Areas into one focus area entitled “Subsurface Contaminants” to reduce program management cost and eliminate duplication.[16]
- Jointly sponsored with EM-40 “Short Term Technology Implementation Project” using 10 technologies.[17]
- Standardized the format and content of the Innovative Technology Summary Reports; and coordinated this summarization process with a similar effort of the Office of Environmental Restoration to maximize the availability and application of information to the private sector and our stakeholders.

III. General Response

The National Research Council Report has addressed the main issues facing the DOE's EM TD Program. The report, however, does not reflect the considerable progress made by the OST program in overcoming issues related specifically to: 1) prioritizing technology development investments, 2) establishing remediation and waste form objectives, 3) project assessment and evaluation, 4) peer review, and 5) inventorying the status and potential application of available and emerging technologies.

Many of the issues raised by the NRC are directed at the formulation and execution of OST investment strategy for research and development (R&D). OST has made significant progress in developing the capacity to formulate a needs-based, R&D investment strategy as more information on the characterization and risk priority rankings is made available from each site. The overall OST R&D strategy provides direction to the formulation of each focus areas' R&D investment strategy, which would guide evaluations of specific projects at decision points throughout the technology development and demonstration process.[18] The environmental restoration and waste management needs form a basis for establishing the focus area strategies. Associated with these needs are: risk evaluations, technology performance requirements, final waste form requirements, compliance and programmatic schedules, and a knowledge of baseline and applicable technologies.

The OST investment strategy addresses not only the integration of the maturity levels of the technology development process (basic research, applied research, engineering and deployment) but also applies the principles of life-cycle systems engineering and analysis to the assessment of progress and the identification of needs.[19] The systems engineering approach requires both the ability to identify problems and the ability to analyze the results of the investment in research. Using the drivers for the program (cost reduction, risk reduction, schedule adherence, and inability to accomplish certain environmental restoration or waste management activities), the basis of the program can be formed. Figure 1 represents a model of the issues associated with the concept of seamless delivery of technological systems to the EM program. The model represents the development of a technology or a technology system, from the evolution of a concept to deployment. The requirements shown at the bottom of the figure represent tasks that must be completed in order for the technology to move toward deployment. This information, coupled with the appropriate engineering documentation, allows a technology to be critically reviewed by a potential user for applicability to a particular problem or problems. As technologies move through each step toward deployment, the technology is reviewed technically and also evaluated against the needs identified by the STCGs.

OST Process/Product Model

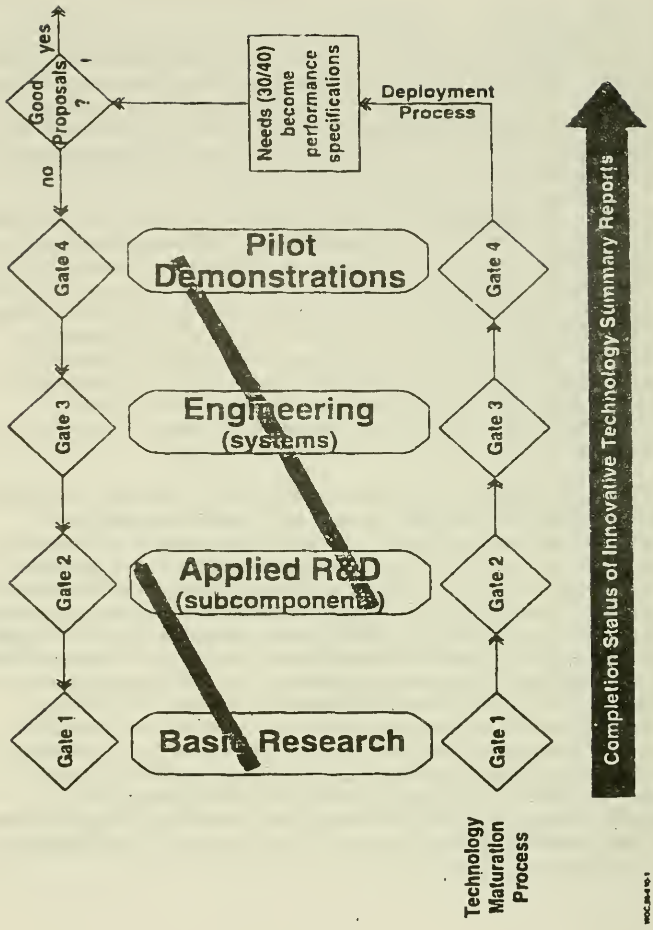

Figure 1

It is important to realize the R&D planning process is dynamic with respect to changing user requirements, maturing regulatory requirements and permitting processes, and an advancing technology baseline.

The efforts that have been made to focus the program towards identifying and prioritizing technology needs, developing systems approaches to formulating R&D strategies at the focus area level, instituting a stage-gate project evaluation framework using peers and other stakeholders for criteria development and technology assessment, and inventorying available capabilities in the private sector, have been made in partnership with the DOE Operations Offices. The Operations Offices, through the OST Board of Directors, has taken ownership of the OST program and become fully involved in the management of the program and pledged to implement the successful technologies developed in the program in lieu of baseline technologies. This level of commitment to the program ensures that the new technologies under development in the OST program are focused on the DOE site's needs, provide a significant risk or cost benefit, and ultimately are selected and managed according to prudent business practices.

A. Identification, Selection, and Priority Ranking (Prioritization) of Technology-Development Investments

> ***Recommendation (page 9):*** *DOE should develop and rank remediation scenarios leading to a prioritized list of technology needs as noted above. The scenarios should be structured to define only the major steps from characterization through disposal (or storage) and to highlight only the major choices to be made. It is important that the scenarios be presented clearly; too much detail can obscure the basic issues.*

The OST technology development priority ranking process is a customer driven process whereby the Site Technology Coordination Groups (STCGs) identify the technology needs at their own site based on the near-term remediation activities, long-term environmental problems, and stakeholder concerns. That information is then examined against the strategic goals of each focus area to derive the R&D investment plans. This process is working well in developing ownership of the OST program at the site level, especially at the sites where there is a strong STCG such as Richland and Oak Ridge.

The process for the systematic analysis of the site needs and the resulting investment strategy used by the Mixed Waste Focus Area (MWFA) has been adopted by OST as the model to be used in other focus areas. The approach uses remediation scenarios, called process flow diagrams, which include unit operations from retrieval to disposal, to cover the entire range of wastes included in the mixed waste inventory report. In the MWFA example, seventeen alternative treatment scenarios were developed for the five categories or "types" of mixed waste. These treatment scenarios were prioritized using the following criteria: volume of waste, number of documented customers, number of waste streams, waste hazard, potential cost savings, time to implement, and DOE commitments. Each of the unit operations within the process flows was evaluated to determine the acceptability of the existing baseline technology, and technology deficiencies. Deficiencies include gaps where no technology exists to serve a unit operation, as well as functions that have unacceptable costs or risks. Deficiencies were prioritized based on a set of criteria to determine how important the deficiency was to the overall waste treatment system. Deficiencies were defined by Waste Type Managers and end-user representatives and were supported by Integrated Thermal Treatment Systems (ITTS) and Integrated Non-Thermal Treatment Systems (INTS) studies, based on knowledge of site needs and waste treatment capabilities. The Waste Type Managers also used needs reports developed by the principal mixed waste sites.[20]

The result of this activity is a defensible matrix of prioritized technical deficiencies relative to specific waste stream scenarios, and the resulting definition of the activities comprising the technical program for the MWFA, referred to as the "technical baseline".[21,22] Based on the success that the MWFA has had using this process, the other focus areas have taken a similar approach in the definition of their technical baselines.

The focus areas, in cooperation with site representatives, usually through the STCGs, have identified remediation and waste management needs, as well as technology gaps across the DOE Complex.[23,27] These "needs statements" have been presented to the OST Board of Directors and are accepted by the Operations Offices as a realistic definition of the sites' needs. The investment plan for each focus area was developed from an examination of these needs, a knowledge of available technologies and those in the pipeline, and the focus area strategic objectives.[28,32]

There is much activity within the STCGs and focus areas to develop and prioritize needs and formulate the appropriate investment strategies. However, there is inconsistency between the activities of the sites and the focus areas. As a result, a process improvement team consisting of headquarters and field personnel is working on a consistent process related to needs identification and priority ranking at both the site and national levels, the development of R&D investment strategies, and the annual budget cycle.[33] The objective of the Process Improvement Team is to couple the clean-up and waste management operations planning with the OST program, resulting in a shared vision for R&D investments.

As has already been noted in the general comments, the OST Program is managed through the application of standard business practices. In an effort to better coordinate OST R&D planning activities with private R&D activities, the focus area leaders met with representatives from Xerox Corporation, DuPont, Dow Brands, and Fluor-Daniel in June

1995 to learn their approaches for R&D Management.[34] The firms discussed the following themes: core competencies and technologies, developing relationships with business units constituting end users for R&D, and developing strategies for technology portfolio management that optimized R&D capabilities while acquiring technology outside their area of core competencies.

OST is also working with other Federal agencies to leverage information and to adopt successful management practices. OST has a Memorandum of Understanding (MOU) with the U.S. Air Force (USAF) Human Systems Center (HSC) to cooperate in needs assessment and R&D planning methodologies.[35] As discussed later in this document, the Plumes Focus Area has adopted certain USAF decision and R&D planning methodologies. The result of this cooperative effort will be to share information related to needs and technology development projects to foster leveraging between the agencies. Similar efforts are underway with the other branches of the Armed Services. The process by which the Air Force maps projects against needs for determining its Tri-Services Environmental R&D Strategy serves as a good model for DOE.[36]

B. Final Disposition of Waste Forms

Recommendation (page 10): A greater focus should be put on defining the required characteristics of the waste streams and the nature of the ultimate waste disposal sites, even if tentative and only as working targets, which is necessary to effectively manage the EM technology development program (see Appendix A for more details).

OST agrees that a technology development program must be driven by the characteristics of the waste streams and the final waste form disposal criteria. All technologies developed must meet a specific need within a treatment scenario that ultimately transforms a waste stream to a disposable final waste form. These treatment scenarios are based on the characteristics of the wastes before and after treatment. To meet this end, the OST is using treatment scenarios to drive the technology development priority ranking and selection process. The treatment scenarios are a path that takes a waste streams or waste streams from a non-compliant state to a disposable state.

OST has put a strong emphasis on waste characterization and on final waste forms technology development. OST priority ranking process favors treatment scenarios that are able to treat multiple waste streams with minimal characterization and that produce waste forms requiring no further treatment.

Presently, there is much data available concerning various final waste form types, their chemical and physical characteristics, and near-term performance with respect to the leachability of the waste form by water and the expected physical durability of the solid. All final waste forms being considered for final disposal are solids.

Previous studies within the Office of Waste Management and the former Mixed Waste Integrated Program (MWIP) focused primarily on the identification of various final waste form options, beginning with considerations of the waste streams to be treated and disposed. The performance criteria was generally limited to requiring that the final waste form pass the EPA-approved Toxicity Characteristic Leach Procedure (TCLP), which is described in 40 CFR 261.app #II. The early work identifying final waste form options [37] covered many types of materials suitable for utilization as a final waste form. These include various vitreous materials such as glasses and ceramics (many types of each are potential final waste form candidates); several types of polymers for micro- and macro-encapsulation including thermosetting polymeric materials such as epoxies, and thermoplastic polymers such as polyethylene; various types of hydraulic cements such as the common Portland cement, gypsum, grout (cements augmented with other materials to act as binders), pozzolan cement, and various polymer-modified cements such as the sulfur polymer cement.

The Hanford Tri-Party Agreement, which mandated the vitrification of low-level tank waste and also the preference for glass as a final waste form for LLW, has resulted in more recent studies within DOE on final waste forms, focusing on the long-term performance of waste glasses, especially in the context of performance within a final repository. Although this is recognized as a major issue for DOE, there is very little consensus within the technical community concerning the requirements for waste form performance, and what test methods are likely to prove reliable in predicting the performance of a final waste form for, say, 10,000 years within an engineered repository.

Several workshops have been held discussing these matters [38,39], but a much more rigorous approach is needed and is being conducted within the Mixed Waste Focus Area (MWFA). The planned waste form study, which will formally begin in FY 1997, will not be restricted to glass as a final waste form. Glass is the preferred option for many of DOE's waste streams, but it is not appropriate for all waste streams; and also, in cases where a less costly option will provide the requisite final waste form performance, prudence requires the utilization of the less costly option. In addition, this study will support not only the MWFA, but the other focus areas and DOE entities as well. Essentially the developers of treatment processes that produce a final waste form for disposal directly will benefit from this work. The initiative will integrate efforts of the DOE's Office of Waste Management, Waste Disposal Group (WDG), a variety of final waste form testing methods, and the analysis of the final waste forms with respect to specific site treatment plans.

C. Project Assessment and Evaluation

Recommendation (page 12): *"DOE should develop clear protocols and performance measures for assessing and documenting the effectiveness of technology-development projects and field applications. Explicit and measurable criteria for success and procedures for evaluation must be included, including external peer review. Specific evaluation procedures should be included as an integral part of projects, and the results of these evaluations should be documented. These procedures should be applied to current and future projects to identify "lessons learned" that could be applied to future decisions. DOE also should develop a process to disseminate the result of such evaluations throughout the complex to ensure that the lessons are indeed "learned" by decision-makers."*

The focus areas have adopted R&D management practices that incorporate decision points (or gates) between the various stages of technology development.[19] The purpose of the gates is to provide an opportunity to evaluate projects against various technical and non-technical criteria and to determine if the technologies should proceed to the next stage of development. The evaluation criteria reflect issues related to technical performance, acceptance requirements of DOE end-users and their stakeholders (e.g., regulators and the affected public), and commercialization potential. The gates reviews also provide an opportunity for evaluation by DOE end-users and other stakeholders, as well as for peer review at the project level. The decision framework adopted by the focus areas ensures

- an understanding of the dynamics for the marketplace early in the development process;
- establishment of formal decision points to determine their investments in R&D projects and eliminate, as early as possible, less relevant or feasible activities; and
- decisions are made that reflect the R&D strategy of the focus area and the overall program.

The Plumes Focus Area (PFA) has been a leader in adopting the stage-gate decision framework [40], although others are now developing project evaluation criteria through dialogue with stakeholder groups, as well as determining the appropriate evaluation procedures. Several technologies have undergone gate reviews with recommendations provided to the focus area managers.[40] It should be noted that project reviews have always been a standard procedure of EM's TD Program. Currently, the program is applying the stage-gate framework for project evaluation and refers to the evaluation procedure as a "gate review." The criteria used by the PFA to assess the feasibility and viability of R&D projects at key decision points include

- appropriateness to meeting a DOE need and time frame for implementation,
- technical merit of the project,
- cost-savings potential,
- risk-reduction potential,
- relative difficulty associated with regulatory acceptance,
- probability of stakeholder (public) acceptance, and
- commercial viability.

The focus areas have been provided general guidance on the stage-gate process, including defining the information and analytical requirements. In addition, standardized reports, called Innovative Technology Summary Reports (ITSRs), are used for capturing information addressing technical, programmatic, cost/benefit, and commercialization issues, as well as providing cost and performance data, to help make R&D project and technology implementation decisions. Thirteen ITSRs have been published to date.[41] The ITSRs provide lessons learned from information from demonstration activities.

D. Life-Cycle Cost Savings Analysis

In addition, as part of the evaluation of programs, OST has estimated the potential life-cycle cost savings that a group of 37 technical systems and subsystems might realize, if these technology systems were aggressively implemented during the life cycle of the DOE cleanup. In addition, OST has prepared guidance on cost estimating.[42] These systems were selected for impact analysis by focus areas staff, and their cost estimating contacts evaluated the emerging technologies that could replace baseline systems (baseline systems are the current treatment or remediation strategy for cleaning up a specific problem at a particular site). The examined systems may provide solutions for risk reduction and cleanup problems, and most importantly, provide essential cost savings. OST is currently in the process of documenting these individual cost savings analyses and resulting impact at the aggregate level across the DOE complex in a preliminary draft report entitled, "Technology Development Impact Analysis: Strategic Investment in Technology Development Will Payoff."[43]

The Technology Development Impact Analysis (TDIA) report [43] is a continually updated document for an on-going process to evaluate individual technology systems/subsystems and their potential cost savings across the EM cleanup program. The methodology and initial results will be included in the upcoming FY96 Baseline Environmental Management Report (BEMR), expected to be issued in Summer 1996. OST is establishing processes to work with the other EM programs to ensure their evaluations and updated data sets (references of baseline systems are identified in FY96 BEMR) are regularly incorporated in the cost savings analyses. Currently, OST is establishing, with stakeholders and other EM offices, ways to evaluate the reasonableness of the initial aggregate level potential cost savings conclusions. Also, it is OST's intention to improve the data consistency, methodology, and structure of the individual technology system cost savings case studies, that are the framework for the TDIA report, to a level of quality that will be sufficient for external peer review. The information for the 37 individual cost savings analysis case studies is consolidated into a work-in-process referenced as "Cost Analyses of Innovative Technologies (Draft)" dated February 1996.[44]

A process for gathering cost and performance data and implementing a Life Cycle Cost Analysis activity within each focus is under development and will be implemented in FY97. This process will use the lessons learned from the development of the TDIA and will be integrated in to the project evaluation and assessment procedures at each gate. The process will require the focus areas to prepare cost data for each technology or technology system under development for comparison against baseline as well as a providing information to the overall cost savings analysis being performed for the complex in the TDIA and the BEMR.

E. Peer Review

> *Recommendation (page 14): "DOE-EM needs to develop and uniformly apply a standardized peer-review process designed to assess the following parameters in all five focus areas: the appropriateness of the identified technology needs, the appropriateness of projects to meet specific technology needs, and the soundness of the technical approach being used or proposed on separate projects."*

At Headquarters and the field, OST has conducted peer reviews since the program's inception. These peer reviews have supported investment decisions 1) at the OST level in the assessment and monitoring of the overall R&D technology development strategy,[45-47] and 2) at the project level to assess and evaluate individual technology efforts to determine their technical merit and to determine funding requirements at critical decision points.[48-56]

Site Technology Coordination Groups (STCGs), comprised of technology developers, site technology users, and external stakeholders, have been conducting reviews at the project level within the Focus Area framework.[57] Review criteria include technical and scientific merit; effectiveness in contributing to national needs; the technical potential of an approach or its successful demonstration; potential for risk reduction and safety improvements; cost-effectiveness; regulatory and public acceptability; and potential for technology transfer and commercialization.

The Environmental Management Advisory Board (EMAB) [58-61], and the Site Specific Advisory Boards (SSABs) [62,63] provide external review and scrutiny of the OST program. These organizations provide evaluations of the overall effectiveness of the EM Technology Development Program to the EM Assistant Secretary.

DOE Operations Office Managers have been reviewing program status. progress, and plans for the entire OST program during the past year.[64-67] They bring the user perspective needed for critical evaluation of program relevance. Programmatic reviews such as the annual mid-year reviews have been held for each focus and crosscut area. Many reviews have been conducted at the OST level since 1992 (including EMAB meetings, SSAB meetings, mid-year reviews and Technology Development Council meetings). Most of these reviews included members from the EM user community, regulators, community leaders, and other agencies.

At the project level, each funded task or Technical Task Plan (TTP) undergoes close scrutiny in a critical technical review involving university and other independent participants. Also at this level, there are specific technical area reviews such as reviews conducted in Dallas and Pittsburgh, for the Landfill Focus Area and MWFA [68,69]; for thermal and non-thermal treatment technologies in August and November, 1995 [70-72]; review of Characterization, Monitoring and Sensor Technology Crosscut technologies in December 1995 [73]; and for review of efficient separations technologies in May 1995, and April 1996.[74,75]

These reviews and similar reviews for the Decontamination and Decommissioning Focus Area in May 1995 [76], and the Tanks Focus Area in March 1996 [77], resulted in selection of the most appropriate technology development efforts to achieve technical and programmatic objectives. More than thirty project level reviews have been conducted since the start of the focus area approach in 1994 (including TTP review meetings, focus area/crosscut mid-year program reviews, and focus area/crosscut program technology reviews).

The Morgantown Energy Technology Center (METC) conducts rigorous technical peer reviews of industry proposals responding to Research Opportunity Announcements (ROAs) and Program Research and Development Announcements (PRDAs).[78] These reviews emphasize the technical merit of the candidate industry projects. The result of the reviews is the selection and funding of the most technically sound projects to meet OST objectives.

Since December 1994, OST has met with the Committee on Environmental Management for Technologies (CEMT) and its subcommittees on fourteen separate occasions including the semiannual technical reviews by the four subcommittees of the CEMT. OST has been operating under the premise that this committee is a peer review panel for programmatic and technical issues. The Committee's Statements of Task cited in the 1995 Report on OST states "the objective of the Committee is to provide independent review and recommendations to the Department of Energy, Assistant Secretary for Environmental Management (DOE-EM), on environmental management technology developments impacting DOE weapons complex facilities." However, as stated in the 1995 report, CEMT does not perceive itself as "technical project review agents." OST is assessing other organizations to provide independent peer review. The reviewers will include representatives from four different areas: recognized technical experts; federal and contractor users who establish performance criteria for technologies; stakeholders knowledgeable about non-technical criteria; and regulators who understand the relationship between technical and non-technical criteria and regulatory requirements.

F. Technology Applications Inventory

> *Recommendation (page 15): "DOE-EM should undertake an explicit effort to inventory the status of technologies relevant to its interests and disseminate the results throughout the program. This inventory should consider both the wastes to be addressed and the conditions (e.g., requirements for remote operation). It should cover both domestic and international venues and all sectors (governments, commercial, academic). Such an inventory will allow DOE-EM to identify those research areas where solutions or partial solutions are already available from external sources, as well as those development areas where major DOE-EM technology-development efforts are required."*

EM has undertaken considerable efforts to develop an open data base for the dissemination of information related to the nature of the environmental problems at the DOE complex and the technology development activities within the OST. This data base can be accessed through the EM home page on the INTERNET. The address of the EM home page is WWW.EM. DOE.GOV. The OST home page may be accessed through the EM home page or can be directly accessed through WWW.EM-50.EM.DOE.GOV.

The OST information inventory is designed to facilitate the acquisition of information about EM technology development programs and allow for comparisons to be made with other information resources both internally and externally. The OST inventory maintains information specific to each research and development project sponsored by the office. The information includes data harvested form a variety of OST internal information resources including the Technical Task Plan system (TTP), financial information systems, Progress Tracking Systems (PTS), Cost Benefit Analysis (CBA), and other information collected for specific requests. The structure of the inventory provides multiple layers of information to be accessible for browsing and searching the OST information inventory. The OST information inventory is consistent with other EM internal data bases such as the Environmental Restoration and Waste Management problem sets and Activity Data Sheets. In addition to being coordinated within EM the OST information inventory is coordinated with other federal agencies responsible for environmental clean up activities and the development of environmental technologies. The linked databases include. EPA's' VISITT, ATTIC, SITES data bases, and DoD's DTIC information service. In addition to the coordination with other offices internally and other federal agencies the OST inventory shares information with the Global Network for Environmental Technologies (GNET).[79] GNET is a OST sponsored environmental information service that includes information on environmental technologies available from the private sector as well as from federal sources. The GNET also provide information on regulations, new innovations, international activities and other information of interest to the environmental professional.

The focus areas have instituted a make/buy policy which is used to identify technologies that are currently available or applicable to DOE cleanup needs prior to determining which technology efforts should be pursued. Examples of the activities to identify other technologies are, the Plumes Focus Area's "Industry Available Technology Matrix" which has identified more than 1000 technologies from the private sector that are applicable to plume remediation [80]; and, the Request-For-Information issued by the MWFA to identify treatment technologies which can be applied to waste management requirements.[81]. OST also routinely issues solicitations to the private sector (e.g., via Research Opportunity Announcements, Small Business Innovation Research Grant Applications, and other contractual vehicles) to fill gaps in DOE's technology capability.

The OST home page has been developed by the Information for Decisions (IFD) program. This program reflects six years of efforts focused on (1) inventorying technology data and associated problem-set data. (2) identifying sources of relevant data and information inside and outside of OST, (3) maintaining a current and valid OST data and information set, (4) providing and improving on efficient, cost-effective, and simple inventory access, and (5) packaging and disseminating this information into an "information Inventory" that is in the most suitable communication format.

The near term focus of the IFD program is to continue the development of the information system to provide search-engines and matching functions for analyzing technology development information and technology needs information (EM problem-sets). This information will be based on the data developed by the STCG's and the ITSRs.

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V. List of Acronyms

ADAS	Associate Deputy Assistant Secretary
BEMR	Baseline Environmental Management Report
BNL	Brookhaven National Laboratory
C/PVA	Cost/Performance Variance Analysis
CEMT	Committee on Environmental Technology Management
D&D	Decontamination and Decommissioning
DAS	Deputy Assistant Secretary
DOE	Department of Energy
EM	Office of Environmental Management
EMAB	Environmental Management Advisory Board
GAO	General Accounting Office
GNET	Global Network of Environment and Technology
HEPA	High Efficiency Particulate Air
HSC	Human Systems Center
INTS	Integrated Non-Thermal Treatment Systems
ITSR	Innovative Technology Summary Reports
ITTS	Integrated Thermal Treatment Systems
LLW	Low-Level Radioactive Waste
METC	Morgantown Energy Technology Center
MOU	Memorandum of Understanding
MWFA	Mixed Waste Focus Area
MWIP	Mixed Waste Integrated Program
NAS	National Academy of Sciences
NRC	National Research Council
OST	Office of Science and Technology
PFA	Contaminant Plumes Containment and Remediation Focus Area
PRDA	Program Research and Development Agreement
R&D	Research and Development
ROA	Research Opportunity Announcements
RTDP	Robotics Technology Development Program
SBIR	Small Business Innovation Research
SSAB	Site Specific Advisory Board
STCG	Site Technology Coordination Group
TCLP	Toxicity Characteristic Leach Procedure
TDIA	Technology Development Impact Analysis
TFA	Tanks Focus Area
TRP	Technology Reinvestment Project
TTP	Technical Task Plan
USAF	U.S. Air Force
WBS	Work Breakdown Structure
WDG	Waste Disposal Group

Q8. On pages 16 and 20 of your prepared testimony, you mentioned the new $50 million science program.

How are these monies to be distributed, i.e., how much will go to fund truly peer-reviewed science and how much will be allocated on a non-peer-reviewed basis to the DOE Labs or other entities?

A8. Of the $50 million for the new science program, approximately $1 million was used to fund the Small Business Innovative Research Program (SBIR), a set-aside imposed on all DOE research programs to fund small businesses, through a separate review process. Approximately $2 million has been used to support solicitation, peer review, and selection activities for the program. All of the remaining $47 million is going to fund truly peer-reviewed science projects at universities, DOE laboratories, and other research organizations. No non-peer reviewed projects at DOE Labs or other entities will be supported with these funds.

The peer review process was the result of a partnership between the Department's Offices of Environmental Management and Energy Research, and has been endorsed by the National Academy of Sciences. Proposals went through a peer review process for scientific merit administered by the Office of Energy Research without regard to the submitting organization. The proposals were then evaluated on their relevance to the Environmental Management program's needs.

One hundred and thirty-eight proposals were selected from 810 submitted. The complete list of award recipients are available on the World Wide Web at: *www.doe.gov/em52/science-grants.html*, or through DOE Public Inquiries Office, Room 1E-206, Washington, D.C. 20585 202/586-5575.

Uranium Mill Tailing Remedial Action Project (UMTRAP)

Q9. What system does the Department use to prioritize the cleanup efforts under the UMTRAP versus cleanup efforts at Hanford, Savannah River, or other such sites?

A9. Due to the unique and often complex environmental issues found at the Hanford Reservation, Savannah River, and other Department sites, the Office of Environmental Management (EM) has developed a prioritization system. The prioritization system is a negotiated process which begins with site managers, since they are best equipped to set priorities at their own sites. Each manager develops five separate priority lists based on: 1) Risk; 2) Compliance; 3) Cost effectiveness, including Mortgage Reduction; 4) Stakeholder Concerns; and 5) Optimization. The fifth priority list, the optimized case, balances the other four priority lists. These priority lists provide the Assistant Secretary for Environmental Management, Headquarters managers, and other decision makers with valuable information to use in determining the funding level for the EM program.

The Uranium Mill Tailings Remedial Project Act, however, mandates that sites are to be prioritized based on the severity of their potential risk to human health. For the Surface Project, this was done in 1979 with assistance from the U.S. Environmental Protection Agency. For the Ground Water Project, this was done initially in 1991 using an external peer-reviewed multi-attribute system heavily weighted toward human health risk. This ranking system was used during the preparation of the Programmatic Environmental Impact Statement for the Uranium Mill Tailings Remedial Action Ground Water Project, with considerable input from external stakeholders. The fiscal year 1998 ground water budget was prepared on the basis of this priority-setting system.

Q10. What type of cost/risk analysis has DOE done for UMTRAP?

A10. To support the enactment of the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), the Department of Energy studied both the human health risks posed by uranium mill tailings and the costs of remediation. Congress subsequently gave the Environmental Protection Agency authority to establish standards for the cleanup and disposal of the contaminated material at Uranium Mill Tailings Remedial Action Program (UMTRAP) sites. In doing so, the Environmental Protection Agency considered risk to the public and the economic costs of applying its standards. EPA's UMTRAP surface remediation and groundwater standards are codified at 40 CFR Part 192. Additional background on the technical and policy basis for these standards are available from the EPA.

In complying with UMTRCA, the Department uses cost/risk analysis to determine the priority and pace for UMTRA site remediation, as well as groundwater compliance strategies to meet the 40 CFR Part 192 standards. For example, these analyses are used by the Department in evaluating proposed cleanup alternatives at individual sites during the National Environmental Policy Act process. The Department is also continuing to use these analysis in selecting groundwater compliance strategies, as allowed by 40 CFR Part 192.

Q11. DOE's FY 1996 Congressional Budget Request indicated that the remaining surface Uranium Mill Tailing Remedial Action Project (UMTRAP) costs for the period FY 1995-FY 1998 were about $300 million (page 98 of volume 5). However, DOE's FY 1997 Congressional Budget Request indicates that these costs for FY 1995-FY 1998 are now about $247 million, of which DOE's portion is about $228 million (page 87 of Volume 5). What accounts for these differences and do you expect any additional increases or decreases in these surface project costs?

A11. Both the 1996 and 1997 annual budget requests included current year costs and out year costs through the end of the UMTRAP in 1998. Hence, the $300 million costs detailed in the fiscal year 1996 Congressional Budget Request included $65 million in fiscal year 1994 costs because the fiscal year 1996 budget request was prepared in 1994. Since the fiscal year 1997 Congressional Budget Request of $228 million was prepared in 1995, it did not include these 1994 costs. In addition, the Department removed $7 million for the remediation of the Belfield and Bowman, North Dakota, sites from its fiscal year 1997 budget request, in anticipation of revoking these sites' designation, as requested by the State of North Dakota.

The fiscal year 1997 and 1998 budget requests should be sufficient to complete the UMTRAP; the Department does not plan to increase or decrease them. However, the final project costs will not be known until all subcontracts are closed out.

Q12. There has been criticism that the cleanup costs at the UMTRA Title I sites (i.e., sites that were inactive at the time of passage of the Uranium Mill Tailings Radiation Control Act of 1978 and for which DOE is responsible) are much higher than the costs of Title II sites (i.e., those that were active at the time of the passage of the Act and cleaned up at the expense of private companies). How do you answer this criticism? Has DOE had unnecessarily high cleanup costs?

A12. The Department does not believe that UMTRA surface project costs have been unnecessarily high. The GAO report that you refer to in Question 14 concluded that the constant dollar cost of the Project increased by only 37 percent from DOE's 1982 estimate, and that the increase was due in large part to real increases in scope that included more stringent EPA ground water protection standards; revised standards for transportation of radioactive materials and worker health and safety; additional quantities of tailings at mill sites and vicinity properties; and changes in cleanup strategies and disposal sites in response to regulatory and stakeholder concerns.

Some of these same factors also are responsible for differences in cleanup costs between Title I and Title II sites. In particular, DOE has had to relocate tailings from 12 of the 22 Title I mill sites, instead of the original plan to relocate only one or two sites. Some of these sites were located in residential or urban areas. In contrast, we believe only one of the Title II sites has required relocation. Obviously, relocation to a remote site is more expensive than reconfiguring an existing tailings pile. The Title I sites were operated and abandoned without plans for permanent disposal that would be protective of public health and the environment. In contrast, many of the licensed Title II sites operated after the Uranium Mill Tailings Radiation Control Act was passed, and as a result many of the tailings impoundments were designed and operated with permanent disposal as part of the plan. Also, as the final custodian of the Title I sites, the Department has had a greater incentive to take a conservative approach in designing and building the final disposal cells to meet the EPA longevity standards of 1000 years and to minimize the active maintenance that will be required.

Q13. DOE's FY 1997 Congressional Budget Request (page 89 of Volume 5) indicates that remaining UMTRAP groundwater cleanup cost have decreased by about $32 million or 5.9 percent since the last estimate contained in the FY 1996 Congressional Budget Request (page 98 of Volume 5). What accounts for these decreased estimates and are there additional cost savings opportunities available?

A13. The Groundwater Program cost estimate reduction is primarily due to a reduction in the number of sites likely to require active remediation and the removal of costs previously identified to pay for water withdrawal at two Native American sites. Under the Department's proposed Ten-Year Plan, which is being prepared, additional cost savings are anticipated by completing thereby shortening project duration and reducing the total program management costs.

Q14. In its report on Uranium Mill Tailings, GAO stated that DOE anticipates completing UMTRAP surface cleanup by early 1997 and that DOE has set a goal of completing licensing by the end of FY 1998 (page 23). This will require close cooperation between DOE and the Nuclear Regulatory Commission (NRC). What steps is DOE taking to ensure that both agencies are able to fulfill the FY 1998 completion date that has been established?

A14. Since the time the GAO report was prepared in 1995, the completion dates for several sites has slipped. These delays are the result of finding significantly larger quantities of tailings at one site, and problems with subcontractor performance or procurement at three sites. All of these problems have been resolved. Of the six sites now under remedial action construction, four are scheduled to be complete by the end of calendar year 1996, and the final two by the end of Fiscal Year 1997. In addition, the cleanup of vicinity properties continues in Grand Junction, Colorado, and the disposal cell will remain open to accept vicinity property material that is remediated and transported by the States or local governments. The disposal cell will remain open until filled or no later than September 30, 2023.

The Department and the Nuclear Regulatory Commission continue to work closely together to coordinate remedial action and licensing activities. Performance measures and milestones for the remaining licensing activities have been jointly developed and are being monitored by senior management from both agencies to assure fulfillment of the Fiscal Year 1998 completion goal. In addition, senior management and staff from both agencies continue to meet frequently to review performance and identify opportunities for increasing licensing efficiency. Numerous steps to reduce licensing document preparation and review times have recently been implemented. Also, NRC plans to assign additional staff to the Project in Fiscal Year 1997.

Q15. If schedule problems develop, what contingency plans do you have to ensure that you will be able to complete all UMTRAP surface remediation by the end of FY 1997 and all site licensing by the end of FY 1998?

A15. The Department currently is on schedule to complete remedial actions by the end of Fiscal Year 1997, which excludes the Belfield and Bowman, North Dakota sites. At the request of North Dakota, the Department is in the process of revoking the designation of these sites under the Uranium Mill Tailings Radiation Control Act of 1978, as discussed in the GAO report referenced in Congressman Rohrabacher's question number 14. The Department has also received a commitment from the Nuclear Regulatory Commission that, under the current cleanup schedule, it will complete all licensing activities by the end of Fiscal Year 1998. Every effort is being made to adhere to these schedules. If unforeseen problems arise, the Department would undertake all necessary corrective actions (e.g., double shifts or other acceleration alternatives) to ensure attainment of the Department's goals for Fiscal Year 1997 and Fiscal Year 1998, provided that these corrective actions do not jeopardize worker and public safety and that funds are available. The actual cleanup of the sites is a higher priority than the site licensing, which is basically an administrative action. If licensing activities fall behind schedule, the Department could request that the Nuclear Regulatory Commission assign additional resources to ensure that licensing activities are completed by the end of Fiscal Year 1998. Unexpended prior year funding could be carried over into Fiscal Year 1999 to complete licensing, but DOE does not anticipate the need to request Fiscal Year 1999 funding for this purpose.

Q16. If UMTRAP receives a reduced budget for the next couple of years, how will it affect DOE's ability to complete the remaining surface cleanup?

A16. To complete surface remedial action at the remaining sites by the end of Fiscal Year 1998, it is essential that Uranium Mill Tailings Remedial Action Project be funded at the level the Department requested in the President's Fiscal Year 1997 Budget Request to the Congress. Otherwise, remedial action completion at one or two sites would need to be deferred from the 1997 construction season to 1998, which, in turn, would increase costs. The current goal is to complete all work so that contracts can be terminated no later than Fiscal Year 1999.

Q17. Once DOE takes over the 45 Title I and Title II UMTRA sites, will this include all sites that DOE will be responsible for providing long-term custody?

A17. For the protection of public health and safety, in accordance with Federal regulations and agreements with the EPA, DOE is required to provide for the long-term custody of sites where contaminated material was controlled rather than treated. Primary requirements include physical inspection, maintenance (as required), record keeping, and ground water monitoring. All sites owned by DOE where permanent waste disposal facilities ultimately exist will be included. In addition to the 45 Uranium Mill Tailings Radiation Control Act Title I (DOE managed) and Title II (Industry managed) sites, DOE will be responsible for the long-term custody of other currently non-DOE owned locations that include: the

Nuclear Waste Policy Act (NWPA) Section 151[c] site in Parkersburg, West Virginia; approximately 13 NWPA Section 151[b] sites; and eight Project Plowshare and Project Gas Buggy sites; as well as the responsibility for the operation of the UMTRA Cheney disposal cell located in Grand Junction, Colorado. Other locations may be established in the future requiring long-term DOE custody as a result of cleanup activities at Formerly Utilized Sites Remedial Action Program (FUSRAP) sites at various locations.

Q18. **In Uranium Mill Tailings report, GAO states that DOE has estimated that it will spend $60 million (in 1995 dollars) between FY 1995 and FY 2030 on its responsibilities for long-term custody at the Title I and Title II sites (page 42). How much does DOE estimate that it will cost to provide long-term custody of the other facilities it will inherit?**

A18. The GAO estimate included Uranium Mill Tailings Remedial Action Title I/Title II, Grand Junction Projects Office Remedial Action Project, Monticello, Nuclear Waste Policy Act, and Formerly Utilized Sites Remedial Action Project sites. Using the long-term custody costs for these sites as a basis, DOE estimates long-term care costs at facilities other than Title I/Title II facilities to be about $38 thousand in 1995 dollars per year, per site. However, costs may be significantly higher, particularly at Comprehensive Environmental Response, Compensation and Liability Act sites, where monitoring requirements exceed Uranium Mill Tailings Radiation Control Act requirements and at mixed waste sites that have State and Federal reporting requirements. In addition, long-term operation costs for the Cheney disposal cell in Utah are estimated to be $145 thousand per year, in 1995 dollars, beginning in FY 1999. Should remedial action be required to maintain the integrity of the disposal facility, costs would be significantly higher on a case-by-case basis.

Formerly Utilized Sites Remedial Action Project (FUSRAP)

Q19. **Please describe FUSRAP. What is it and how does if differ from UMTRAP?**

A19. The Formerly Utilized Sites Remedial Action Project (FUSRAP) covers the cleanup of 46 radioactively-contaminated sites in 14 states, which the Department has found to be contaminated with radioactivity that exceeds current cleanup guidelines and with which the Department previously had some involvement. DOE's predecessor, the Atomic Energy Commission (AEC), started FUSRAP in 1974 to study sites throughout the United States where work was performed during the 1940s, 1950s and 1960s, as part of the Nation's early atomic energy program. Some sites' activities can be traced back as far as World War II, to activities of another DOE predecessor, the Manhattan Engineer District (MED); other sites were involved in peacetime activities of the Atomic Energy Commission (AEC). Most sites that became contaminated during the early atomic energy program were cleaned up under the guidelines in effect at the time. In most cases, those cleanup guidelines were not as strict as current guidelines. Over the years, contamination was spread to other locations, either by demolition of buildings, intentional movement of materials, or by natural processes.

When a site is thought to be contaminated, old records are reviewed and the site is surveyed. If contamination is found that is connected to MED or AEC activities, cleanup is authorized by DOE under FUSRAP. Under FUSRAP, DOE has examined records or performed surveys on more than 400 sites. Most were not contaminated; but 46 sites in 14 states have been found to be contaminated with radioactivity that exceeds current cleanup guidelines. This number includes five sites being cleaned up under FUSRAP as decontamination research and development projects in response to Congressional direction. No external standards have been established for FUSRAP sites by EPA, but the DOE standards being applied at these sires are the same as the standards that were promulgated by EPA for the Uranium Mill Tailings Remedial Action Project (UMTRAP) sites under 40 CFR part 192.

Limited cleanup began at some FUSRAP sites in 1979, and substantial remedial action has been underway since 1981. Cleanup has been completed at 23 of the sites; 19 others have been partially cleaned up. More than 175 contaminated vicinity properties, including homes, parks and streams have also been remediated.

While FUSRAP generally focuses on the remediation of sites that processed uranium metal, which resulted from commercial uranium milling operations, UMTRAP focuses on cleaning up contamination from 24 inactive uranium milling sites and contaminated vicinity properties. FUSRAP medial actions are conducted under the Atomic Energy Act or the Comprehensive Environmental Response, Compensation, and Liability Act. UMTRAP is authorized by the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA). UMTRCA directed the Department to clean up those sites which are specifically designated under that Act, and to stabilize, dispose, and control the uranium mill tailings in a safe and environmentally sound manner.

Under UMTRAP, DOE is in the process of cleaning up about 24 million tons of uranium tailings in 10 states and more than 5,000 contaminated vicinity properties (residences, businesses, and open lands where the tailings were used as fill dirt or other uses that contaminated the area).

Q20. How hazardous are FUSRAP sites?

A20. Although the Formerly Utilized Sites Remedial Action Project (FUSRAP) sites contain levels of radioactivity above current DOE guidelines, given current land uses, none of the sites pose an immediate health risk to the public or environment. The contaminated materials generally have very low concentrations, and people are not exposed to them for long periods of time. Although these materials do not currently pose any short-term risk given the current land use, they will remain radioactive for thousands of years. Under FUSRAP, sites are typically remediated to levels necessary to meet reasonably anticipated future land uses, such as residential development, recreational use, or commercial/industrial operations.

Q21. How does FUSRAP work and how is it organized?

A21. The larger FUSRAP sites undergo several steps that lead to cleanup. First, information about the site is collected and reviewed. Then, a remedial investigation/feasibility study is conducted. The remedial investigation identifies the type and location of the contamination. The feasibility study develops and evaluates cleanup alternatives. Throughout the remedial investigation/feasibility study process, the public is informed about the progress toward a decision on the cleanup alternative.

When a preferred cleanup alternative is chosen, a proposed plan is written to explain why that alternative was selected. Members of the public are asked to comment on all the cleanup alternatives, including the preferred alternative. After public comments are considered, a final decision is made and documented in a record of decision. The remedial design follows the record of decision and includes technical drawings and specifications that show how the cleanup will be conducted. Cleanup begins after the remedial design is complete. This phase involves site preparation and construction activities. When these activities are completed, verification surveys are conducted to ensure that cleanup objectives for the site have been met.

The smaller FUSRAP sites undergo a somewhat different review and documentation process. Taking the place of a remedial investigation/feasibility study and proposed plan, are:

- A site radiological characterization, a more detailed version of the preliminary radiological assessment;
- An engineering evaluation/cost analysis (EE/CA), which lists the range of cleanup options available and identifies the DOE's preferred option; and
- An action memorandum, authorizing a cleanup to proceed.

The public has the opportunity to review and comment on the site EE/CA. Under special circumstances, a site cleanup may proceed without the issuance of an EE/CA–proceeding directly from characterization to cleanup.

FUSRAP currently consists of a headquarters program office and a field project office to execute the site cleanup activities. The headquarters office provides direction on program policy, priorities, schedule and budget, which is in turn implemented at the Oak Ridge Operations Office. Technical, administrative, and financial management of FUSRAP activities are the responsibility of the Former Sites Restoration Division of the DOE Operations Office in Oak Ridge, Tennessee. DOE hires companies to manage and carry out the FUSRAP activities.

A project management contractor conducts site maintenance and monitoring, remedial investigations, and cleanups, and provides project integration support to DOE. An environmental services contractor plans site investigations, evaluates cleanup alternatives, and ensures that all FUSRAP activities comply with environmental requirements.

Q22. **DOE's FY 1997 Congressional Budget Request indicates that total project cost (TPC) for FUSRAP has gone from $867.9 million in the previous cost estimate to $1.006 billion for the period FY 1996 - FY 2001 (page 111 of Volume 5). This represents an increase of $138.6 million, or nearly 16 percent. What accounts for this increase?**

A22. The Formerly Utilized Sites Remedial Action Program is a multi-year program with life-cycle costs estimated to 2016, the year in which the Department has committed to completing the program. The annual Congressional budget submission includes only a portion of the total estimated cost–that which occurs within the seven year window presented in the budget. Each year when a new budget is submitted, the costs of one additional outyear are added into the total program costs, along with any adjustments to the baseline plan that may have been necessary during the year. These two factors are the cause of the increase in total project cost from year to year.

West Valley Demonstration Project

Q23. **DOE's FY 1997 Congressional Budget Request says that the West Valley Demonstration Project will cost more than $1.52 billion through the completion of Phase I, which occurs in the third quarter of FY 1998, with DOE paying about $1.37 billion.**

What is Phase I of the Project, and when will a decision be made on whether or not to proceed with Phase II?

A23. Phase I of the project includes high-level radioactive waste pretreatment, and construction and operation of a vitrification facility to solidify the high-level waste.

Phase II of the Project includes solidification of residual waste and performance of decontamination and decommissioning activities as mandated in the West Valley Demonstration Project Act, P.L. 96-368.

Some Phase II work, including transition activities, is currently underway.

A Draft Environmental Impact Statement that addresses the majority of Phase II activities is undergoing public review. It is projected that a Record of Decision on these activities will be issued late in CY 1997.

Ms. Bernice Steinhardt
Associate Director
Energy, Resources, and Science Issues
Resources, Community, and Economic Development Division
U.S. General Accounting Office

Followup Questions and Answers

GAO
United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

September 4, 1996

The Honorable Dana Rohrabacher
Chairman, Energy and Environment
Subcommittee
Committee on Science
House of Representatives

Dear Mr. Chairman:

This letter responds to your August 6, 1996, request that we provide followup information on issues arising from a May 1, 1996, hearing before your Subcommittee. The hearing focused on the Department of Energy's (DOE) cleanup efforts under the Uranium Mill Tailings Radiation Control Act of 1978. The enclosure contains GAO's response to the Subcommittee's questions. Our responses are based upon our previous audit work and our followup discussions with DOE officials.

Should you have additional questions or want to discuss our responses further, please call me at (202) 512-6543.

Sincerely yours,

Bernice Steinhardt

Bernice Steinhardt
Associate Director, Energy,
Resources and Science Issues

Enclosure

GAO'S RESPONSES TO THE SUBCOMMITTEE'S QUESTIONS

Question 1: Does GAO believe that the Uranium Mill Tailings Remedial Action Project (UMTRA) is a model cleanup program where DOE has been able to do its job at a reasonable cost?

GAO's Response: Our review objectives did not include examining the quality of DOE's cleanup program or the reasonableness of its costs. However, in our May 1, 1996, testimony before your Subcommittee,[1] we stated that only a small portion of DOE's environmental restoration projects have been completed. Under its UMTRA project, in contrast, DOE's cleanup of at least the surface contamination is near completion. In reviewing the status and cost of the surface cleanup, we found that as DOE's surface cleanup at the Title I sites grew in size and complexity, its costs increased 37 percent more than DOE anticipated.

Question 2: On page 40 of your Uranium Mill Tailings report, it is stated that DOE has identified five sites where it believes there is a 50-percent chance that a more expensive alternative may be required. What is the likelihood of this occurring and how much more money may be required?

GAO's Response: We did not review DOE's methodology for determining the likelihood of a site's requiring a more expensive alternative than estimated. At the time of our review, the groundwater program was in the early stages of development, so the likelihood of concerns being raised by the affected entities or of possible technical problems arising was largely unknown. Based on the information it had at the time of our review, DOE estimated that implementing the more expensive alternative approaches at the five sites could cost an additional $72 million.[2]

As of August 13, 1996, a DOE groundwater official said that the $72 million estimate has not been revised. However, since our report was issued,[3] progress has been made toward resolving some of the reported uncertainties surrounding the groundwater cleanup. For instance, DOE has had discussions with all of the affected states and Indian tribes regarding the proposed cleanup strategies. In all but one case, the discussions did not indicate that the states or tribes will desire a more expensive groundwater cleanup strategy than the one planned. In the one case, a site located on tribal lands, a more expensive active remediation cleanup strategy might be required. At three other sites, however, a less costly cleanup approach might be used. These three sites were not among the five sites that DOE believed that there was a 50-percent chance that a more expensive alternative would be required. The DOE official believes that the groundwater program will probably cost less than previously estimated. To date, however, no new cost estimates have been developed that either support or refute this belief.

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[1] DOE Cleanup: Status and Future Costs of Uranium Mill Tailings Program (GAO/T-RCED-96-167, May 1, 1996).

[2] This amount is in present value 1995 dollars.

[3] Uranium Mill Tailings: Cleanup Continues, but Future Costs Are Uncertain (GAO/RCED-96-37, Dec. 15, 1995).

Question 3: How many uranium mill tailings disposal cells will DOE be responsible for maintaining in the future?

GAO's Response: DOE is expected to acquire long-term custody of all its Title I sites and most or all of the Title II sites. DOE estimates that after 2010, it will be responsible for monitoring and maintaining 19 Title 1 sites and 26 Title II sites. Although states have the option of assuming the long-term custody of the cleaned-up Title II sites, DOE does not expect that any states will choose to do so.

Question 4: What will happen if the Belfield and Bowman sites in North Dakota are not delisted?

GAO's Response: According to a DOE official as of August 13, 1996, DOE is actively pursuing the delisting of the Belfield and Bowman sites. Interim steps to delist need to be completed in order for DOE to complete its expected delisting by December 1996. Prior to this time period, DOE will provide written notification of its intent to the Congress, and an announcement will be published in the Federal Register.

Question 5: In GAO's December 1995 Uranium Mill Tailings report, it was noted on page 38 that by late spring of 1996 DOE plans to start shutting down its work at those sites where cleanup is not complete unless its authority is extended beyond FY 1996. Is this still the case?

GAO's Response: According to a DOE official as of August 13, 1996, DOE has not terminated or slowed its scheduled cleanup because agency officials believed that the program would be reauthorized.

Question 6: What is the likelihood that DOE will require another extension of the Uranium Mill Tailings Radiation Control Act of 1978 beyond the two years it is currently seeking?

GAO's Response: According to a DOE official as of August 13, 1996, DOE will not be seeking another extension of its surface cleanup activities beyond the 2 years it is currently seeking.

Dr. E. William Colglazier
Executive Officer
National Academy of Sciences and National Research Council

Followup Questions and Answers

NATIONAL RESEARCH COUNCIL

2101 CONSTITUTION AVENUE WASHINGTON, D.C. 20418

EXECUTIVE OFFICE

August 29, 1996

The Honorable Dana Rohrabacher
Chairman
Energy and Environment Subcommittee
Committee on Science
U.S. House of Representatives
2320 Rayburn House Office Building
Washington, D. C. 20515-6301

Dear Chairman Rohrabacher:

I am pleased to respond to your letter of August 6, 1996, with replies to the four questions that you posed regarding my testimony on May 1. My testimony was presented at the Energy and Environment Subcommittee hearing on Authorization of the Department of Energy's Enforcement, Health and Safety, Environmental Restoration, Waste Management and Nuclear Energy Budgets for FY 97.

Question 1: On page 1 of your prepared testimony, you state that you would commend to the committee the fact that to an unusual degree, the EM program has been willing to subject itself to a great deal of objective, outside review, especially from the National Research Council, which indicates a willingness to find and correct problems and to make improvement in the program. What specific improvements have been made since the issuance of your most recent reports?

Response: The EM program (with the possible exception of OCRWM) has requested more independent assessments from the National Research Council than any other office at DOE, especially in the last few years. Many of the NRC reports have contained detailed criticisms and suggestions for improvement of EM programs. The EM program managers, in my opinion, have attempted to respond seriously to the criticisms and recommendations in the NRC reports, as indicated by the recent DOE document, "Improving the Environment, Next Steps: Response to the National Academy of Sciences' Report Improving the Environment: An Evaluation of DOE's Environmental Management Program," April, 1996. In addition, EM officials have continued to request additional NRC studies and assessments of various parts of the program. Regarding specific improvements, my testimony pointed to four key areas where the Department is particularly deserving of mention and praise (taken from the NRC report Improving the Environment): (1) the new research and development initiative aimed at bringing the Departments and others basic-research capabilities to bear on EM cleanup problems, (2) the introduction of performance-based integrated contracting that includes the elements of a Department contract-reform initiative, (3) integration of risk and long-term cost data into the budgeting process, and (4) a substantial and effective effort to improve stakeholder participation.

Another example is the Department's responsiveness to objective advice provided by the work of the NRC Committee on Environmental Management Technologies, which was appointed to help the Office of Science and Technology (EM-50) increase the effectiveness of its technology development programs. One of the principal recommendations in the committee's most recent (April 1996) report is that EM-50 should implement a rigorous system of peer review for all of its technology development programs. EM-50 has already begun to implement this recommendation and, in fact, it has requested the committee's assistance in establishing an effective peer review program. The committee is continuing its assessment of EM-50 programs and will be issuing future reports. Two forthcoming NRC reports, which will be issued in September, will address in more detail the new EM research and development initiative and the Waste Isolation Pilot Plant. These reports may be able to give you indication of specific improvements that are being made as well as where more work is needed.

Question 2: You use the term stakeholders several times in your prepared testimony and it is one of DOE's favorite terms. Yet it appears in most instances that the stakeholders include the vested interests while the taxpayers who have to foot the bill do not have a seat at the table and are presented a bill from the stakeholders. How can this circumstance best be remedied?

Response: I will give you my personal opinion. The question that you have raised is a very important one that in my view was neglected in the early days of negotiations of various triparty agreements, in part because cleanup costs were not well understood when these agreements were made. For this reason, I believe that close coordination between OMB and DOE, as well as Congressional oversight, is needed during the process of negotiating and modifying these agreements. These compliance agreements can be used most effectively for implementation of better routes to cleanup. Since it appears likely that the total EM budget will be capped for the next few years, the main focus for DOE and the stakeholders, in my opinion, should be setting priorities for projects and making tradeoffs among competing criteria (e.g., reducing current and future risks, reducing future costs, making land available for productive uses, etc.) to ensure that limited resources are spent most effectively each year.

Question 3: On page 6 of your prepared testimony, you stated: A key to achieving changes in the operation of the Environmental Management Program will be clear leadership from the Secretary. Has such leadership been absent? What does the Secretary need to do differently?

Response: The statement from my testimony was quoted from the NRC report Improving the Environment. I believe that the intent of the committee which wrote this report was that several key tasks, such as creating a civil-service program that provides more incentives for performance, hiring more technically knowledgeable people who are able to judge contractor cost estimates in the context of what the work in intended to accomplish, and developing more performance-based contracting, can only be accomplished in a government agency with committed and sustained leadership at the highest level. I do not think that the NRC committee was prepared to judge the Secretary's efforts to date, but rather to raise this issue and highlight it for the Secretary.

Question 4: At the bottom of page 8 and the top of page 9 of your prepared testimony you stated: The decision as to whether national Laboratories, universities, or industry should take the lead in a basic-research effort or in the development of any particular technology should be based on a competitive process that undergoes external review, not on a formula or some other form of entitlement. Teaming together and partnering these different groups is often the most-effective approach. National Laboratories constitute an extraordinary technical resource both in capability and in size. It must be recognized, however, that the laboratories are unique in culture and expertise (especially with nuclear materials); this can be both an advantage and a disadvantage in bringing new technologies and science to bear in the Environmental Management Programs activities. However, it appears that only $20 million out of the $50 million of the new EM science program will be awarded on a peer-reviewed basis. Do you agree that this is the right amount or do you think it is too little.

Response: As you may know, the NRC recently created a committee at the request of EM to provide advice on the structure and management of this new Environmental Management Science Program. The committee released its first report, entitled Building an Effective Environmental Management Science Program, on July 9. In its report, the committee commended the Department for using scientific peer review as the basis for making award decisions. The committee also recommended that the Department relax, to the extent allowed by law, its plans to allocate $20 million to support university researchers and $20 million for national laboratory researchers--and instead provide support for the most scientifically meritorious and relevant research projects, regardless of institutional origin. I understand that the Department utilized the expertise of researchers from industry, universities, and national laboratories to assess the merit of the 810 proposals submitted to the program in FY1996 and for making all of its award decisions. I also understand that the Department followed the committee's recommendation about the $20 million/$20 million funding allocation and provided funding to the most meritorious proposals regardless of institutional origin. In my opinion, the work of this committee exemplifies the Department's willingness to seek and utilize objective outside advice to improve the effectiveness of its programs.

I hope that my responses to your questions have been of some use. I along with members of the NRC staff would be happy to meet with your staff to discuss any of these issues. Thank you again for the opportunity to comment.

Sincerely,

E. William Colglazier, Ph.D.
Executive Officer

cc: ✓Dr. Harlan Watson
Mr. Tom Grumbly
Mr. Alvin Alm
Dr. Clyde Frank

Dr. Terry R. Lash
Director
Office of Nuclear Energy, Science and Technology
U.S. Department of Energy

Followup Questions and Answers

HEARING OF THE SUBCOMMITTEE ON ENERGY AND ENVIRONMENT
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

on

The Department of Energy's FY 1997 Budget Requests for Environment, Safety and Health, Environmental Restoration and Waste Management (Non-Defense) and Nuclear Energy

Wednesday, May 1, 1996

Followup Questions Submitted to

Dr. Terry R. Lash, Director, Office of Nuclear Energy, U.S. Department of Energy

Advanced Light Water Reactor (ALWR) Program

Q1. On page 5 of your prepared testimony you stated: ". . . our light water reactor efforts focus on technical issues that affect broad sections of the industry, and rely on the special expertise located within the Department of Energy and at its multi-program laboratories."

Please define the unique expertise provided by the DOE and its labs in the (a) Design Certification and (b) First-of-a-Kind-Engineering (FOAKE) programs.

A1. The DOE laboratories have contributed significantly to the Advanced Light Water Reactor Programs. The RELAP5 and TRAC computer codes developed respectively at the Idaho National Engineering Laboratory and at the Los Alamos National Laboratory are two of the fundamental tools used in designing such next generation plants as the Westinghouse AP600 and General Electric Simplified Boiling Water Reactors. The DOE severe accident research programs conducted at Sandia National Laboratory and at the Argonne National Laboratory have yielded results and methods that directly support the severe accident prevention and mitigation features of the ALWRs.

DOE, due to its long involvement in the development of nuclear power, has developed a deep understanding of the policy and technical issues that are critical to maintaining the nuclear power option in the United States. As a result, DOE initiated the Design Certification and FOAKE programs. These programs which are near completion are important in maintaining the nuclear power capability in the 21st century, but these programs would never have been started without the leadership and sponsorship of the Department. As the programs proceed, the Department provides technical and managerial oversite to assure that the programs focus on the key technical and programmatic issues. In this process, the Department has, on a limited basis, involved the national laboratories to perform important supporting technical analyses. Although DOE initiated these programs, and administers them along with industry partners, the primary responsibility for the conduct of the Design Certification and FOAKE programs rests with the designers: the General Electric Company for the Advanced Boiling Water Reactor and Simplified Boiling

Water Reactor designs, ABB Combustion Engineering for the System 80+ design, and Westinghouse Electric Corporation for the AP600 design.

Q2. On page 7 of your prepared testimony you stated that the Department's cooperative agreement with the Advanced Reactor Corporation to conduct the FOAKE program "specifies that the Department will receive a pro-rata share of any royalties received by the Corporation based on the Department's contribution to the program. (ARC royalties are $75,000 for each $1 million provided to a vendor in the program for sales within 20 years of the contract date.) In addition, any funds that the Department provides to vendors beyond $50 million for design certification are reimbursed through initial plant sales."

However, in his testimony, Mr. Freedman stated that "the cooperative agreement states that sales of reactors to utilities that are members of the Advanced Reactor Corporation (ARC) are not subject to royalties for cost recovery."

Is Mr. Freedman correct, and if so, does this mean that DOE will unlikely receive any royalties from future domestic sales if they ever materialize?

A2. As Mr. Freedman states, Article 6.c. of Appendix C to the Cooperative Agreement, included as an attachment to our response to question 5 below, excludes domestic class 1 members of the Advanced Reactor Corporation from being subject to royalties for cost recovery. However, of 49 utilities that operate nuclear power plants in the United States, only 11 electric utilities are class 1 members of the Advanced Reactor Corporation. These 49 utilities are potential future purchasers of advanced light water reactors, and the Federal Government would receive royalties from the Advanced Reactor Corporation for any purchases of advanced reactors developed in the FOAKE program by any of them that is not a class 1 member of ARC.

Q3. In his prepared testimony, Mr. Freedman stated that a GE Advanced Boiling Water Reactor (ABWR) supported under FOAKE began operation in Japan earlier this year and that GE has now sold at least two other ABWRs to Japanese utilities.

Q3a. Is Mr. Freedman's statement true, and if so, when does DOE expect to receive any royalties?

Q3b. Has DOE brought this matter up with GE?

A3. Two Japanese Advanced Boiling Water Reactors (ABWR) did begin operation this year. These reactor plants are Units 6 and 7 of Tokyo Electric Power Company's Kashiwazaki-Kariwa Nuclear Power Station. These 1350 MWe ABWRs were developed as a joint venture between Japanese companies, including Tokyo Electric Power, and General Electric (GE). This ABWR design was later used as a starting point for the DOE ABWR Certification program and the First-of-a-Kind Engineering (FOAKE) program. DOE and Advanced Reactor Corporation (ARC) do have royalty rights on the sale of the ABWR design developed under the FOAKE program. However, neither DOE nor the Advanced Reactor Corporation have any royalty rights on the GE sale of the K-6 and 7 units because the DOE program did not develop this ABWR design.

Moreover, the ABWR design built in Japan represents an older technology that would not meet domestic utility requirements and U.S. codes and regulatory standards. For example, utility requirements led to the addition of an onsite gas turbine generator for Station Blackout considerations, and NRC safety considerations led to a change in the orientation of the turbine building to minimize the potential for turbine blade missile damage to containment. Additionally, severe accident considerations led to the inclusion of a containment overpressure protection system, prohibition of limestone concrete in the lower drywell, a flooding system for the lower drywell, and an AC independent water addition capability. The ABWR designed in cooperation with the Department meets all these requirements and represents one of the most advanced nuclear plant technologies available in the world.

Recently, the Taiwan Power Company announced that it had selected the U.S.-sponsored GE advanced boiling water reactor design for planned construction of two new plants in its Lungman Project. Once these plants are completed, the Federal Government will receive from General Electric some $3 million in royalties plus interest accrued during the construction period.

Q4. How much money did DOE provide GE for its recently canceled Simplified Boiling Water Reactor and what plan does the Department have for recovering any taxpayers' monies from this failed venture?

A4. Over a period of seven years, the Department invested $50 million towards the Design Certification of the Simplified Boiling Water Reactor (SBWR) while General Electric and its cosponsors invested approximately $120 million. This was a joint venture with industry, that was not set up with cost reimbursement provisions for the Government contributions. However, for any plants sold by GE over the next 25 years that apply SBWR technology, the Government will receive a royalty of $3.9 million for the first and $2.4 million for the second plant sold. The program yielded many significant technical advances and the testing required to verify the design features was completed. Therefore, from a technology standpoint, the Department considers the SBWR program to have been quite successful, and, after a lengthy evaluation, DOE has found no basis for seeking funding recovery from GE. The work left undone involved the interface with the Nuclear Regulatory Commission reviewers to achieve Design Certification.

Q5. Please provides copies of all cooperative agreements between DOE and non-Federal entities for the (a) Design Certification and (b) First-of-a-Kind-Engineering (FOAKE) programs.

A5. Attached are copies of the Cooperative Agreement between DOE and the Electric Power Research Institute for the Advanced Light Water Reactor Program dated October 1, 1985, and between DOE and the Advanced Reactor Corporation for the FOAKE program dated February 14, 1992.

EPRI
Electric Power
Research Institute

October 1, 1985

Mr. James W. Vaughan, Jr.
Acting Assistant Secretary
for Nuclear Energy
Department of Energy
Washington, D.C. 20585

Dear Mr. Vaughan:

We have reviewed the "Agreement between DOE and EPRI for cooperation in an Advanced Light Water Reactor Program" which was forwarded to me with your September 19 letter.

The Agreement is acceptable to us, except for the wording in the last sentence of subparagraph E of paragraph IV, "Scope of Cooperative Activities." We have no objection to the principle of exchanging work on other programs which support the objectives of the DOE/EPRI Advanced LWR cooperative program. However, our preferred approach to such exchanges is that DOE and EPRI identify work from other programs for exchange on a case-by-case basis. We have deleted the words "and exchanged" in the last sentence of subparagraph E, which is consistent with the version that was sent to Del Bunch by John Taylor on August 16.

I have signed the original copy of the Agreement which you sent and have included in it a replacement page 3 which reflects deletion of the words "and exchanged." We are returning that copy to you for your records. Since we received only one original copy from you for signature, we have prepared another original copy for our records, which I have signed, and are forwarding it to you for your signature. Please sign that copy and return it to me.

We look forward to working with DOE on the Advanced Light Water Reactor cooperative program.

Sincerely,

Richard E. Balzhiser
Senior Vice President
Research & Development

Duly Acknowledged and Accepted:
Department of Energy
James W Vaughan, Jr.
Name: James W. Vaughan, Jr.
Title: Acting Assistant Secretary
for Nuclear Energy
Date: October 2, 1985

RLH:REB:dw

Enclosures

3412 Hillview Avenue Post Office Box 10412 Palo Alto CA 94303 Telephone (415) 855-2000

AGREEMENT
BETWEEN
THE UNITED STATES DEPARTMENT OF ENERGY (DOE)
AND
THE ELECTRIC POWER RESEARCH INSTITUTE, INC. (EPRI)
FOR
COOPERATION IN AN ADVANCED LIGHT WATER REACTOR (LWR) PROGRAM

I. PURPOSE

A. In recognition of continuing cooperation in areas of mutual interest to DOE and EPRI, the parties entered into a Participation Agreement as of September 29, 1981. The Participation Agreement replaced previous Memoranda of Understanding between DOE or its predecessor agencies and EPRI. The Participation Agreement provides for cooperation between the parties in the advancement of safety, reliability, efficiency, environmental compatibility, and commercial acceptability of systems for the production, transmission, distribution, conservation, and utilization of electric energy.

B. In furtherance of the desire of the parties to continue their cooperative efforts, the parties are desirous of cooperating in an effort to enable application of the best U.S. industry's modern technology to building and operating nuclear powerplants. This document sets forth the understanding which the parties have reached concerning the Advanced LWR Program effort. It is the intention of the parties to expand these understandings in the future and to develop definitive project arrangements.

II. BACKGROUND

The Nuclear Utility Industry has authorized the EPRI to embark on an Advanced LWR Program to help assure the availability of the "nuclear option" for the expansion of electric generating capacity in this country. The program is based on an emerging consensus that if nuclear power is to remain a viable power generation option for the 1990's, when orders for new plants are expected to increase, then an effort must be made now to simplify, improve, and standardize plant design. The program will also explore possibilities for building relatively small nuclear plants to provide a viable economic alternative for individual utilities to meet the forecasted load growth and generation capacity growth.

The DOE supports technology programs that assist the process of regulatory reform or that enables use of new plant systems and features to overcome the existing barriers to commercial use of LWR's.

III. OBJECTIVE

The objective of the parties is to cooperate in the development, review, and approval of a detailed Requirements Document specifying the design of simplified LWR plants with standardized components and to support the development of smaller-sized LWR concepts. To assure that the results of the program reflect the needs of utilities, are consistent with the latest available technology, and are acceptable to the Nuclear Regulatory Commission (NRC), the program entails cooperative efforts by electric utilities, EPRI, reactor vendors, architect/engineers, NRC, and DOE. Utilities believe that maintaining the nuclear option for future deployment within a realistic timeframe requires that such plants be based on current proven technology, but that these plants must be simplified and possess more predictable licensing and construction schedules. They also believe that the extensive operational experience can be applied within the bounds of proven technology to achieve enhanced availability, operability, maintainability, and safety.

IV. SCOPE OF COOPERATIVE ACTIVITIES

A. It is anticipated that this cooperative program will be focused on achieving the goals and milestones leading to a utility and NRC Approved Requirements Document and the development of one or more conceptual designs of reactors of small size. The DOE will structure related LWR technology, safety, and regulatory-related tasks to reflect those goals and milestones.

B. Pursuant to the September 29, 1981, Participation Agreement, EPRI will have sole management and contracting responsibility for its Advanced LWR Program. However, one DOE member will be assigned to the program as Deputy Project Manager-DOE interface. That DOE member will fully participate in all reviews of contractor work under the EPRI-sponsored program.

C. Recommendations for supporting technology programs to be pursued by DOE will be made by a DOE-EPRI Advanced LWR Reactor Program Committee. Members of this committee will be selected by the Assistant Secretary for Nuclear Energy, DOE, and the Vice President, Nuclear Power, EPRI. Final selection of the recommended areas will be made by the Assistant Secretary for Nuclear Energy as part of the normal DOE budget process. Once the selections are made, DOE will contract separately for the accomplishment of its work. Contracting will be done through DOE Field Offices; technical program management will be done in the DOE-HQ office in Germantown. Periodic review of the progress of work will be conducted by the DOE-EPRI Advanced LWR Reactor Program Committee and recommendations made as appropriate on revisions to the program. Draft reports on the work will be provided to EPRI and other program participants for review and comment prior to issuing topical or final reports.

D. The details for program coordination will be specified in a DOE-EPRI Management Plan, to be completed within 60 days of the execution of this Agreement.

E. Each organization has other research and development activities that will support the Purpose and Objectives in this Agreement, but which are not an integral part of the cooperative work described herein (e.g., DOE program on Assessment of Severe Accidents in Advanced Designs; EPRI program on Plant Availability). It is expected that work on these other programs will be discussed as applicable during the course of this Agreement.

F. If jointly funded efforts are agreed upon by the parties, the principles of II. H. 1, 2, 3, and 5 of the Participation Agreement shall apply as set forth in definitive project arrangements. If either parallel or sequential cooperative efforts are agreed upon by the parties, the principles of II. H. 1, 2, 4, and 5 shall apply as set forth in definitive project arrangements.

V. FUNDING AND OTHER RESOURCES

Subject to the approval of funds by EPRI's Board of Directors, it is the intent of EPRI to provide funding for management and conduct of selected technical tasks for its Advanced LWR Program during calendar years 1986-1989 to support the cooperative effort. The EPRI's present planned funding levels for 1986, 1987, and 1988 inclusive are on the order of $13 million.

Subject to the availability of appropriated funds, it is DOE's intent to provide up to $5 million in FY 1986 to fund work that will assist in making advanced designs less sensitive to the uncertainties and variabilities of the regulatory process and in increasing safety margins and to attempt to obtain funding in FY 1987 and beyond comparable to the electric utility contribution through EPRI.

It is the intent of the parties that each party will be responsible for the salaries and associated expenses for its own personnel. To augment the industry effort, support will be solicited by EPRI from the industrial contractors participating in the development of the Requirements Document and the small reactor conceptual designs.

VI. POINTS OF CONTACT

Within 30 days from the effective date of this Agreement, the signatories hereto will identify the individual(s) within their respective organizations who will be charged with the development of the definitive plans and agreements necessary to implement this Agreement.

(October 1, 1985
replacement page 3)

VII. TERM

This agreement will be effective when signed on behalf of both parties and will remain in force and full effect to the completion of the Advanced LWR Program or until September 30, 1989, whichever first occurs, unless extended by the mutual agreement of both parties or terminated earlier by written notice of either party at least 60 days prior to the date of termination.

The parties hereto have executed this Agreement, effective this 2nd day of October, 1985.

James W Vaughan Jr
James W. Vaughan, Jr.
Acting Assistant Secretary
for Nuclear Energy
U.S. Department of Energy

2 October 1985
Date

Richard E. Balzhiser
Richard E. Balzhiser
Senior Vice President
Electric Power Research Institute

2 Oct. 1985
Date

Frank

Department of Energy
Chicago Operations Office
9800 South Cass Avenue
Argonne, Illinois 60439

FEB 14 1992

Mr. C. W. Fay, Executive Director
Advanced Reactor Corporation
1685 Horns Corners Road
Cedarburg, WI 53012

Dear Mr. Fay:

SUBJECT: COOPERATIVE AGREEMENT NO. DE-FC02-92NE34267 FOR FIRST OF A KIND ENGINEERING TO SUPPORT COMMERCIAL STANDARDIZATION

Enclosed for your review and acknowledgement are four signed copies and one unsigned copy of the subject Cooperative Agreement which provides an initial increment of $2,000,000.00. Subject to the availability of additional funds, the Department of Energy (DOE) anticipates obligating an additional $1,023,154 for the current budget period. Please have four copies of this document signed and dated on behalf of the Advanced Reactor Corporation (ARC), and return three fully acknowledged copies to me within fifteen days. You may retain the other fully signed copy and the unsigned copy of this document for your records.

Financial reporting under this grant includes submission of the enclosed SF-272, "Federal Cash Transactions Report," and SF-269A, "Financial Status Report," both due 30 days after the end of each quarter. Also enclosed is SF-1034, "Public Voucher," which is to be used when requesting payment.

Technical reporting requirements are contained in Appendix D, "Federal Assistance Reporting Checklist." All Technical Progress Reports and the Final Technical Report must be accompanied by two completed copies of the attached DOE Form 1332.15, "DOE and Major Contractor Recommendations for Announcement and Distribution of Documents."

To assist you with the NONDISCRIMINATION article of your Federally assisted program, enclosed is a brochure entitled "Equal Opportunity in Federally Assisted Programs," and a copy of Code of Federal Regulations 10 CFR 1040, entitled "Nondiscrimination in Federally Assisted Programs." In addition, the enclosed poster entitled "Equal Opportunity in Federally Assisted Programs" should be displayed in a prominent location.

It is the Department of Energy's (DOE's) policy to eliminate fraud, waste, and abuse in DOE programs and to ensure that corrective action is taken when such acts of misconduct are uncovered. As a DOE award recipient, such violations should also be of concern to ARC. DOE is requesting, from its awardees, voluntary compliance and cooperation to help eliminate such violation by displaying the enclosed poster in a conspicuous location in your facility. You may reproduce the poster if additional copies are needed.

Should you have any questions concerning the above, please contact me at 708/252-2069.

Sincerely,

Barbara J. Lewandowski

Barbara J. Lewandowski
Contract Specialist
Contracts Division

Enclosures:
1. Cooperative Agreement (5 cys)
2. SF-272
3. SF-269A
4. SF-1034
5. DOE Form 1332.15
6. EEO Brochure
7. 10 CFR Part 1040
8. EEO Poster
9. Fraud, Waste, and Abuse Poster

cc: Dir., Contracts Division, EPRI, w/Encl. 1
Michael L Miller, Sidley & Austin, w/Encl. 1

Department of Energy
Chicago Field Office

Contracts Division

DISTRIBUTION FORM FOR
ER AWARDS

Document No.: ADVANCED REACTOR CORPORATION
COOPERATIVE AGREEMENT NO. DE-FC02-92NE34267.A000

TO	OFFICE	DATE 3/20/92	DIST. OF SIGNED DOCUMENT
	Contractor		1
	Office of Counsel		1
	Financial Management Division - FCR		1
	w/FMD cy of PR		
	File		1

TO		DATE	DIST. OF CONFORMED DOCUMENT
	Financial Management Division - FAS		1
	(Only for Cost-type Contracts including		
	CPFF, Cost, CSHR, CPIF/AF, or Labor-		
	Hour Agreements or Cooperative		
	Agreements or SBIR Grants)		
	Office of Intellectual Property Counsel		1
	w/cy of Pre-Award Information		
	Sheet if not previously provided		
	PROGRAM DIVISION -		1
	Acquisition and Assistance Management		
	Division ER-64		
	Office of Management		
	Office of Energy Research, HQ-GTN		
	GTR - FRANK A ROSS, NE-42/GTN		1

REMARKS:

Distributed by:

AA-10-1
11/91

DOE F 4600.1 (3-85)

NOTICE OF FINANCIAL ASSISTANCE AWARD

Under the authority of Public Law Atomic Energy Act of 1954; and 95-91, Department of Energy Organization Act and subject to legislation, regulations and policies applicable to *(cite legislative program title)*:

Office of Nuclear Energy

1. PROJECT TITLE First of a Kind Engineering to Support Commercial Standardization	2. INSTRUMENT TYPE ☐ GRANT ☒ COOPERATIVE AGREEMENT
3. RECIPIENT *(Name, address, zip code, area code and telephone No.)* Advanced Reactor Corporation 1685 Horns Corners Road Cedarburg, WI 53012	4. INSTRUMENT NO. DE-FC02-92NE34267 5. AMENDMENT NO. A000 6. BUDGET PERIOD FROM: 2/18/92 THRU: 2/28/93 7. PROJECT PERIOD FROM: 2/18/92 THRU: 9/30/96
8. RECIPIENT PROJECT DIRECTOR *(Name and telephone No.)* C. W. Fay 414/377-5788	10. TYPE OF AWARD ☒ NEW ☐ CONTINUATION ☐ RENEWAL ☐ REVISION ☐ SUPPLEMENT ☐
9. RECIPIENT BUSINESS OFFICER *(Name and telephone No.)* C. W. Fay 414/377-5788	
11. DOE PROJECT OFFICER *(Name, address, zip code, telephone No.)* Frank A. Ross, NE-42 U. S. Department of Energy Washington, DC 20585 301/903-4416	12. ADMINISTERED FOR DOE BY *(Name, address, zip code, telephone No.)* Barbara J. Lewandowski, Contract Specialist U. S. Department of Energy 9800 South Cass Avenue Argonne, Illinios 60439 708/252-2069

13. RECIPIENT TYPE ☐ STATE GOV'T ☐ INDIAN TRIBAL GOV'T ☐ HOSPITAL ☐ FOR PROFIT ORGANIZATION ☐ INDIVIDUAL ☐ OTHER *(Specify)*
☐ LOCAL GOV'T ☐ INSTITUTION OF HIGHER EDUCATION ☒ OTHER NONPROFIT ORGANIZATION ☐ C ☐ P ☐ SP

14. ACCOUNTING AND APPROPRIATIONS DATA

a. Appropriation Symbol	b. B & R Number	c. FT/AFP/OC	d. CFA Number
[illegible]224.91	AF-11-30	YA/CH/410	N/A

15. EMPLOYER I.D. NUMBER/SSN To Be Assigned.

16. BUDGET AND FUNDING INFORMATION

a. Current Budget Period Information		b. Cumulative DOE Obligations	
(1) DOE Funds Obligated This Action	$ 2,000,000	(1) This Budget Period *[Total of lines a.(1) and a.(3)]*	$ 2,000,000
(2) DOE Funds Authorized for Carry Over	$ -		
(3) DOE Funds Previously Obligated in This Budget Period	$ -	(2) Prior Budget Periods	$ - 0 -
(4) DOE Share of Total Approved Budget	$ 3,023,154		
(5) Recipient Share of Total Approved Budget	$ 3,023,154	(3) Project Period to Date *[Total of lines b.(1) and b.(2)]*	$ 2,000,000
(6) Total Approved Budget	$ 6,046,308		

17. TOTAL ESTIMATED COST OF PROJECT $ 200,000,000

(This is the current estimated cost of the project. It is not a promise to award nor an authorization to expend funds in this amount.)

18. AWARD/AGREEMENT TERMS AND CONDITIONS

This award/agreement consists of this form plus the following:

a. Special terms and conditions (if grant) or schedule, general provisions, special provisions (if cooperative agreement)

b. Applicable program regulations *(specify)* N/A *(Date)* N/A

c. DOE Assistance Regulations, 10 CFR Part 600, as amended, Subparts A and ☐ B (Grants) or ☒ C (Cooperative Agreements).

d. Application/proposal dated 1/10/92, ☒ as submitted ☐ with changes as negotiated

19. REMARKS

See attached Page No. 2 of this Notice of Financial Assistance Award.

20. EVIDENCE OF RECIPIENT ACCEPTANCE	21. AWARDED BY
3-16-92 *(Signature of Authorized Recipient Official)* *(Date)*	David T Goldman 2/14/92 *(Signature)* *(Date)*
JAMES J. O'CONNOR *(Name)*	David T. Goldman, Acting Manager *(Name)*
CHAIRMAN *(Title)*	Contracting Officer *(Title)*

DOE F 4600.1 (3-85)

NOTICE OF FINANCIAL ASSISTANCE AWARD

Under the authority of Public Law Atomic Energy Act of 1954; and 95-91, Department of Energy Organization Act and subject to legislation, regulations and policies applicable to *(cite legislative program title)*:

Office of Nuclear Energy

1. PROJECT TITLE
First of a Kind Engineering to Support Commercial Standardization

2. INSTRUMENT TYPE
☐ GRANT ☒ COOPERATIVE AGREEMENT

3. RECIPIENT *(Name, address, zip code, area code and telephone No.)*
Advanced Reactor Corporation
1685 Horns Corners Road
Cedarburg, WI 53012

4. INSTRUMENT NO.
DE-FC02-92NE34267

5. AMENDMENT NO.
A000

6. BUDGET PERIOD FROM: 2/18/92 THRU: 2/28/93

7. PROJECT PERIOD FROM: 2/18/92 THRU: 9/30/96

8. RECIPIENT PROJECT DIRECTOR *(Name and telephone No.)*
C. W. Fay 414/377-5788

9. RECIPIENT BUSINESS OFFICER *(Name and telephone No.)*
C. W. Fay 414/377-5788

10. TYPE OF AWARD
☒ NEW ☐ CONTINUATION ☐ RENEWAL
☐ REVISION ☐ SUPPLEMENT ☐

11. DOE PROJECT OFFICER *(Name, address, zip code, telephone No.)*
Frank A. Ross, NE-42
U. S. Department of Energy
Washington, DC 20585 301/903-4416

12. ADMINISTERED FOR DOE BY *(Name, address, zip code, telephone No.)*
Barbara J. Lewandowski, Contract Specialist
U. S. Department of Energy
9800 South Cass Avenue
Argonne, Illinios 60439 708/252-2069

13. RECIPIENT TYPE
☐ STATE GOV'T ☐ INDIAN TRIBAL GOV'T ☐ HOSPITAL ☐ FOR PROFIT ORGANIZATION ☐ C ☐ P ☐ SP ☐ INDIVIDUAL ☐ OTHER *(Specify)*
☐ LOCAL GOV'T ☐ INSTITUTION OF HIGHER EDUCATION ☒ OTHER NONPROFIT ORGANIZATION

14. ACCOUNTING AND APPROPRIATIONS DATA

a. Appropriation Symbol	b. B & R Number	c. FT/AFP/OC	d. CFA Number
24 91	AT-11-30	YA/CH/410	N/A

15. EMPLOYER I.D NUMBER/SSN
To Be Assigned.

16. BUDGET AND FUNDING INFORMATION

a. Current Budget Period Information

(1) DOE Funds Obligated This Action	$ 2,000,000
(2) DOE Funds Authorized for Carry Over	$ –
(3) DOE Funds Previously Obligated in This Budget Period	$ –
(4) DOE Share of Total Approved Budget	$ 3,023,154
(5) Recipient Share of Total Approved Budget	$ 3,023,154
(6) Total Approved Budget	$ 6,046,308

b. Cumulative DOE Obligations

(1) This Budget Period *(Total of lines a.(1) and a.(3))*	$ 2,000,000
(2) Prior Budget Periods	$ - 0 -
(3) Project Period to Date *(Total of lines b.(1) and b.(2))*	$ 2,000,000

17. TOTAL ESTIMATED COST OF PROJECT $ 200,000,000
(This is the current estimated cost of the project. It is not a promise to award nor an authorization to expend funds in this amount.)

18. AWARD/AGREEMENT TERMS AND CONDITIONS

This award/agreement consists of this form plus the following:
a. Special terms and conditions (if grant) or schedule, general provisions, special provisions (if cooperative agreement)
b. Applicable program regulations *(specify)* N/A *(Date)* N/A
c. DOE Assistance Regulations, 10 CFR Part 600, as amended, Subparts A and ☐ B (Grants) or ☒ C (Cooperative Agreements).
d. Application/proposal dated 1/10/92, ☒ as submitted ☐ with changes as negotiated

19. REMARKS
See attached Page No. 2 of this Notice of Financial Assistance Award.

20. EVIDENCE OF RECIPIENT ACCEPTANCE
3-16-92
(Signature of Authorized Recipient Official) *(Date)*
JAMES J. O'CONNOR
(Name)
CHAIRMAN
(Title)

21. AWARDED BY
David T Goldman 2/14/92
(Signature) *(Date)*
David T. Goldman, Acting Manager
(Name)
Contracting Officer
(Title)

18. Award/Agreement Terms and Conditions (continued)

The uniform administrative requirements set forth in OMB Circular A-110 apply to this Agreement as provided in 10 CFR 600.

19. REMARKS (continued)

a. The following terms and conditions, attached hereto, are made a part hereof:

    i. Federal Assistance Budget Information Form

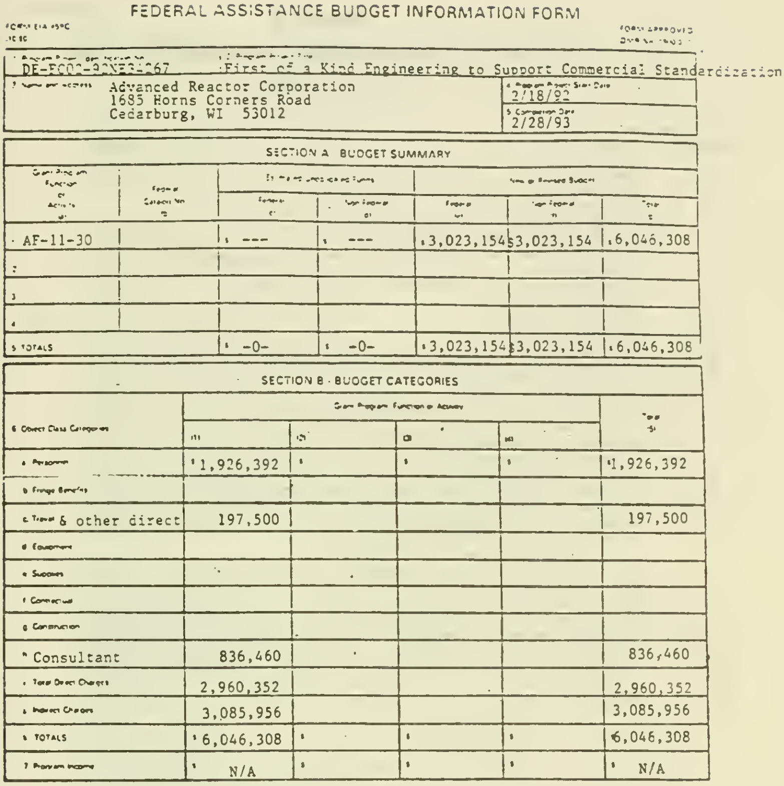
    ii. Appendix A, DOE General Terms and Conditions for Research Awards - ARC-1091

    iii. Appendix B, Intellectual Property Provisions - GPNSB-987 (Modified - ARC)

    iv. Appendix C, Special Provisions

    v. Appendix D, Statement of Work, Deliverables, and Reporting Requirements Checklist

b. All references to grant(s) contained herein shall be interpreted to mean Cooperative Agreement(s). All references to the term grantee, awardee, participant, or recipient contained herein shall be interpreted to mean the Advanced Reactor Corporation (ARC).



FEDERAL ASSISTANCE BUDGET INFORMATION FORM

1. Program/Project Identification No. DE-FC02-92NE34267
2. Program/Project Title First of a Kind Engineering to Support Commercial Standardization
3. Name and Address Advanced Reactor Corporation
1685 Horns Corners Road
Cedarburg, WI 53012
4. Program/Project Start Date 2/18/92
5. Completion Date 2/28/93

SECTION A BUDGET SUMMARY

Grant Program Function or Activity (a)	Federal Catalog No. (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. AF-11-30		$ ---	$ ---	$3,023,154	$3,023,154	$6,046,308
2						
3						
4						
5 TOTALS		$ -0-	$ -0-	$3,023,154	$3,023,154	$6,046,308

SECTION B - BUDGET CATEGORIES

6 Object Class Categories	Grant Program Function or Activity				Total (5)
	(1)	(2)	(3)	(4)	
a Personnel	$1,926,392	$	$	$	$1,926,392
b Fringe Benefits					
c Travel & other direct	197,500				197,500
d Equipment					
e Supplies					
f Contractual					
g Construction					
h Consultant	836,460				836,460
i Total Direct Charges	2,960,352				2,960,352
j Indirect Charges	3,085,956				3,085,956
k TOTALS	$6,046,308	$	$	$	$6,046,308
7 Program Income	$ N/A	$	$	$	$ N/A

APPENDIX A

DOE GENERAL TERMS AND CONDITIONS FOR RESEARCH AWARDS

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1. EXPLANATION.

   a. These general terms and conditions do not restate all the provisions of applicable statutes and regulations, nor do they represent an exhaustive listing of all requirements applicable to this grant. Rather, they highlight and are consistent with those requirements which are especially pertinent to research awards in general. They are emphasized by inclusion here because: (1) they are invoked with high frequency; (2) their violation is a matter of especially serious concern (e.g., use of human subjects); (3) restating them in the research context will allow them to be more easily understood by the research community.

   b. In addition to these general terms and conditions, the awardee must comply with all governing requirements, including those identified in block 18 of DOE F 4600.1, "Notice of Financial Assistance Award," and those included in the "Special Provisions" attached to this award.

2. ADHERENCE TO TERMS AND CONDITIONS.

   a. The Advanced Reactor Corporation's (ARC) signature on the application and on DOE F 4600.1 signifies ARC's agreement to all terms and conditions of the award. Should the awardee believe modification of any of the terms and conditions of this award is necessary, an authorized official of that organization must submit a written request on its own behalf or on behalf of any subcontractor or applicant for prior approval of the Contracting Officer named in the "Special Provisions" attached to this award.

   b. Following this procedure is very important because many of the terms and conditions of this award are required by statute and must be enforced by the Department of Energy.

3. DEFINITIONS.

   a. Principal Investigator. As used herein, the engineer/scientist or other programmatic expert named in block 8 of DOE F 4600.1 designated by the awardee organization to direct the scientific/technical efforts being supported (also called program director or project director/leader).

   b. Prior Approval. A statement in writing, signed by the Contracting Officer, that a cost may be incurred or an action may be taken. The approval may take the form of a letter or a revision to the award. If actions or costs requiring prior approval are specified in the application and are not expressly disapproved by DOE in the attached "Special Provisions," the award of the Cooperative Agreement constitutes such prior approval.

4. AUTHORIZED SIGNATURES FOR PRIOR APPROVAL REQUESTS. All requests for prior approval must be signed by an individual who is authorized to act for the awardee organization. The signature of the principal investigator (unless also a corporate officer or otherwise authorized) is insufficient to obtain action on a prior approval request, although countersignature by the principal investigator is not discouraged. Requests for budget revisions shall be made using the same budget format as used in applying for the award and must be supported by a narrative justification. Other prior approval requests may be made by letter. Prior approval requests should be addressed to the Contracting Officer named in the "Special Provisions" attached to this award.

5. ALLOWABLE COSTS/APPLICABLE COST PRINCIPLES.

   a. In accordance with the applicable cost principles cited below, the allowable costs of this award shall consist of the actual allowable direct costs incident to performance of the project, plus the allocable portion of the allowable indirect costs, if any, of the organization, less applicable credits. The allowable costs shall not exceed the amount shown on the face page of this award for the total approved budget for the current budget period (line 16a.(6), DOE F 4600.1, "Notice of Financial Assistance Award").

   b. The allowability of costs for work performed under this cooperative agreement and any subsequent subaward will be determined in accordance with the Federal cost principles applicable to the awardee or subrecipient in effect on the date of award or the date of the subaward, except as modified by other provisions of this grant or the subaward. The awardee or subrecipient shall specify in any cost-reimbursement contract under the award or subaward the applicable cost principles cited in this provision that apply to the subcontractor.

   c. The Federal cost principles applicable to specific types of awardees, subrecipients, and contractors under cooperative agreements and subawards are as follows:

      (1) Institutions of Higher Education. Office of Management and Budget (OMB) Circular A-21, "Cost Principles Applicable to Grants, Contracts, and Other Agreements with Institutions of Higher Education," is applicable to both public and private colleges and universities.

      (2) State and Local Governments and Indian Tribal Governments. OMB Circular A-87, "Cost Principles Applicable to Grants, Contracts and Other Agreements with State and Local Governments," is applicable to State, local, and Indian tribal governments, and shall also be used to the extent appropriate for foreign governments.

      (3) Hospitals. Title 45 CFR Part 74, Appendix E, "Principles for Determining Costs Applicable to Research and Development under Grants and Contracts with Hospitals," applies to nonprofit and for-profit hospitals.

(4) Other Nonprofit Organizations and Individuals. OMB Circular A-122, "Cost Principles Applicable to Grants, Contracts, and Other Agreements with Nonprofit Organizations," applies to nonprofit organizations and individuals, except for those specifically exempted by the terms of the circular or those nonprofit organizations and individuals covered by the cost principles cited in paragraph 5.c.(1), (2), or (3) above.

(5) Commercial Firms and Certain Nonprofit Organizations. Title 48 CFR Subpart 31.2, "Contracts with Commercial Organizations," as supplemented by 48 CFR Subpart 931.2, applies to those nonprofit organizations not covered by OMB Circular A-122, and to all commercial organizations not covered by the cost principles in paragraph 5.c.(3).

6. PAYMENT.

a. Payments under this award will be made by an advance payment method unless DOE determines that the awardee's financial management system does not meet the requirements of 10 CFR 600.109 or the awardee has not maintained or demonstrated the willingness and ability to maintain procedures that will minimize the time elapsing between transfer of funds from the U.S. Treasury and their disbursement for grant-related purposes.

b. The appropriate advance payment method or the reimbursement method and the cognizant DOE finance office are specified in Section 2 of the attached Appendix C "Special Provisions."

c. Advances by the awardee to subcontractor organizations must conform substantially to the same standards of time and amount that govern advances made by the Federal Government to the awardee. Excess cash advances erroneously withdrawn from the U.S. Treasury shall be promptly refunded to DOE unless the funds will be disbursed within 7 calendar days or the amount is less than $10,000 and will be disbursed within 30 calendar days.

d. Interest earned on advance payments to other than State governments or their subgrantees shall be reported on SF-272, "Report of Federal Cash Transactions," and promptly remitted to the cognizant finance office by check payable to the Department of Energy (unless otherwise specified in the attached "Special Provisions").

7. PREAWARD COSTS.

a. All Awards. Any preaward expenditures are made at the recipient's risk. Approval of preaward costs by the Contracting Officer or incurrence by the recipient does not impose any obligation on DOE if an award is not subsequently made, or if an award is made for a lesser amount than the recipient expected.

b. Research Awards Only.

(1) For new or renewal research awards, recipients may incur preaward costs up to ninety days prior to the effective date of the award. Preaward costs for periods preceding 90 days prior to the effective date of the award are allowable only if approved in writing, prior to incurrence, by a DOE Contracting Officer.

(2) For continuation awards within a multiple year project, prior to receipt of continuation funding, preaward expenditures by recipients are not subject to the limitation or approval requirements of paragraph 7.b.(1) of this section.

(3) Preaward costs, as incurred by the recipient, must be necessary for the effective and economical conduct of the project, and the costs must be otherwise in accordance with these rules and may not include those specific costs for which agency prior approval is required under the circulars. In any instance in which the circulars permit the agency to grant prior approval to the recipient, it is the Department's intention to do so.

This provision covering preaward costs does not apply to bid and proposal costs that may be recovered through an indirect cost rate negotiated in accordance with the applicable Federal cost principles.

8. REPORTING REQUIREMENTS.

a. Attached to the award in Appendix D, Section 3, is a completed EIA 459A, "Federal Assistance Reporting Checklist," a checklist of the reports required under the agreement. (See 10 CFR 600.115 for general reporting requirements.)

b. The recipient shall submit a technical progress report (also called a performance report) as part of any application for continuation or renewal of DOE support. Upon completion or termination of each Phase of the project, a final technical report shall be prepared which is a comprehensive report of the results achieved during the Phase. The report should be a technically oriented account of the investigation, summarizing all work activities performed during the Phase and providing a comprehensive description of the results achieved. It should also include necessary tabulations of data, figures, photographs, pertinent references, and bibliographic citations. To assure the report is technically comprehensive, the report may contain Limited Rights Data under the conditions of use stipulated in Appendix B, Article 6 (Rights in Technical Data) of this Agreement. However, in this case, a less detailed version of the same report also should be provided which deletes the information that is restricted from general dissemination under the provisions of Article 6.

c. As indicated in Appendix D, Section 2, the reporting requirements applicable to the Phase 3 plant design contractors will be identified by mutual agreement of ARC and DOE prior to the start of Phase 3.

d. Instructions concerning financial reports to be submitted in conjunction with this award are specified in the "Special Provisions."

9. COST SHARING.

a. As shown on the face page of the award and Section 4 of Appendix C, any cost sharing shall defray only the allowable costs of the project in accordance with the statutes, regulations, applicable cost principles, and other terms and conditions governing the award. Cost sharing contributions may be incurred either as direct or indirect costs, and include cash or in-kind contributions by the awardee or subcontractors. The cost sharing may be in any allowable budget category or combination of categories. When a direct cost item represents some or all of the non-Federal contribution, any associated indirect costs may not be charged to Federal funds but may be counted as part of the cost sharing. The classification of contributed costs as direct or indirect must be consistent with the classification of similar items charged to DOE funds.

b. Valuation of in-kind contributions and documentation of cost sharing shall be in accordance with 10 CFR 600.107.

10. CONTINUATIONS, RENEWALS, AND EXTENSIONS.

a. Recipients are responsible for ensuring that properly completed applications for continuation awards are received no later than 4 months prior to the expiration date of the current budget period shown on the DOE F 4600.1.

b. If a recipient wishes to apply for a renewal award to receive funding beyond the scheduled expiration of the existing project period, a properly completed application must be submitted to DOE no later than 6 months prior to the scheduled expiration date of the project period as shown on the DOE F 4600.1.

c. Extensions. (1) Recipients of research awards may extend the expiration date of the final budget period of the project (thereby extending the project period) if additional time beyond the established expiration date is needed to assure adequate completion of the original scope of work within the funds already made available. A single extension, which shall not exceed twelve months, may be made for this purpose, and must be made prior to the originally established expiration date. The recipient must notify the cognizant DOE Contracting Officer in the awarding office in writing within ten days of making the extension. (2) DOE may extend any budget period of any type of financial assistance without the need for competition or a justification of restricted eligibility if: (i) In the case of the final budget period of a project period, the additional time necessary is 18 months or less in total, or for all other budget periods, the additional time necessary is 6 months or less in total; and (ii) the grantee submits a written request for an extension before the expiration date of the budget period in process and includes a justification for the extension along with an expenditure plan for the use of any additional funds requested. An expenditure plan need not be provided when no additional funds are requested, unless the recipient intends to rebudget funds in such a way as to require DOE prior approval or unless the grantee is instructed otherwise by the Contracting Officer.

11. MAXIMUM DEPARTMENTAL OBLIGATION to the recipient is the amount shown on the DOE F 4600.1. DOE shall not be obligated to make any additional, supplemental, continuation, renewal, or other award for the same or any other purpose.

DOE intends to continue support for the program through Phase 3 subject to the availability of appropriated funds and satisfactory progress of Phases 1 and 2 initially funded under this agreement

12. PROPERTY.

a. Real and Tangible Personal Property.

(1) No real property may be acquired under this award.

(2) Title to any equipment (for the purposes of DOE grants, equipment comprises any article of tangible personal property that has a useful life of more than 2 years and an acquisition cost of $500 or more) or supplies acquired by a nonprofit institution of higher education or a nonprofit organization, the primary purpose of which is to conduct scientific research, shall vest in the recipient without further obligation or accountability to the U.S. Government. However, DOE retains the right to transfer ownership of any item of equipment having a unit acquisition cost of $1,000 or more under the conditions specified in 10 CFR 600.117(d)(2). This exemption is derived from Public Law 95-224, The Federal Grant and Cooperative Agreement Act of 1977, as amended (31 U.S.C. 6306).

(3) Title to equipment and supplies acquired by all other grantees shall vest in the grantee. However, such grantees shall be accountable for equipment with a unit acquisition cost of $1,000 or more acquired under this grant as specified in 10 CFR 600.117(d)(2), (3), and (4). For such grantees, unused supplies exceeding $1,000 in aggregate current fair market value shall be accounted for at closeout. In this case DOE shall be compensated in an amount computed in accordance with section 600.117(e) if the supplies are retained for use on non-Federal activities.

(4) All recipients shall follow property management policies and procedures that provide for adequate control of the acquisition and use of the assets acquired under the grant.

b. Intangible Property. The treatment and reporting requirements of patent and data rights and copyrights are specified in Appendix B of the grant.

13. CHANGE OR ABSENCE OF THE PRINCIPAL INVESTIGATOR OR DESIGNATED KEY PERSONNEL. A change of principal investigator or of the level of effort of the principal investigator is considered a change in the approved project. Departmental concurrence must be obtained prior to any change of the principal investigator or, in certain cases, others who may have been identified as key personnel in the "Special Provisions" of the grant. The grantee is encouraged to contact DOE immediately upon becoming aware that any of these changes are likely to be proposed, but in any event must do so and receive Departmental approval before effecting any such change.

14. CHANGES IN OBJECTIVES OR SCOPE. Any change in the objective or scope of the project requires the prior approval of DOE. This includes changes in the phenomenon or phenomena under study and in the methodologies or experiments if they are a specific objective of the research work as stated in the application approved by DOE.

15. TRANSFER OF SUBSTANTIVE PROGRAMMATIC EFFORT. None of the substantive effort of the project may be transferred by contract or subgrant to another organization or person without the prior approval of DOE. This provision does not apply to the procurement of equipment, supplies, materials, or general support services; these services may, however, be subject to other prior approval requirements (e.g., those found in the applicable cost principles or procurement standards).

16. CONSULTANT SERVICES. Costs of consultant services are allowable in accordance with the applicable cost principles. These principles include the requirement that the consultant not be an employee of the grantee organization.

17. PAPERWORK REDUCTION.

    a. The award is subject to the requirements of the Paperwork Reduction Act of 1980 as implemented by the Office of Management and Budget rules, "Controlling Paperwork Burdens on the Public," published at 5 CFR 1320 (48 FR 13666, 3-31-83). These requirements apply if the grantee will collect information from ten or more respondents at the specific request of DOE, or if the award requires specific DOE approval of the information collection or the collection procedures.

    b. The awardee shall submit any proposed sponsored information collection under paragraph 17.a., above, to the contracting officer named on the face page of this award. The proposal shall be submitted at least 120 days prior to the intended date of information collection. DOE will seek the requisite approval from the Office of Management and Budget and will promptly notify the grantee of the disposition of the request.

18. GENERALLY APPLICABLE REQUIREMENTS. In accordance with 10 CFR 600.12, this grant is subject to a number of statutory and other generally applicable requirements. Those requirements most pertinent to research projects are highlighted below:

a. Any recipient performing research on vertebrate animals shall comply with the Laboratory Animal Welfare Act of 1966, as amended (7 USC 2131 et seq.), and the regulations promulgated thereunder by the Secretary of Agriculture (9 CFR subchapter A, parts 1, 2, 3, and 4) pertaining to the care, handling, and treatment of vertebrate animals held or used for research, teaching, or other activities supported by Federal awards. The recipient is expected to ensure that the guidelines described in Department of Health and Human Services (DHHS) Publication No. (NIH) 85-23, "Guide for the Care and Use of Laboratory Animals," are followed and to comply with the "U.S. Government Principles for the Utilization and Care of Vertebrate Animals Used in Testing, Research and Training" (included as an Appendix to the NIH Guide).

b. Research Involving Recombinant DNA Molecules. Any grantee performing research involving recombinant DNA molecules and/or organisms and viruses containing recombinant DNA molecules agrees by acceptance of this grant to comply with the National Institute's of Health "Guidelines for Research Involving Recombinant DNA Molecules," 6-83 (48 FR 24556) or such later revision of those guidelines as may be published in the Federal Register.

c. Use of Human Subjects in Research, Development, and Related Activities. Any DOE grantee performing research, development, or related activities involving human subjects must comply with regulations found at 10 CFR Part 745, "Protection of Human Subjects," and any additional provisions which may be included in the "Special Terms and Conditions" of the grant. Such provisions are intended to safeguard the rights and welfare of human subjects at risk of possible physical, psychological, or social injury as a consequence of their participation.

19. NONDISCRIMINATION. The grant is subject to the provisions of 10 CFR 1040, Nondiscrimination in Federally Assisted Programs.

20. PUBLIC ACCESS TO INFORMATION.

a. The Freedom of Information Act, as amended, and the DOE implementing regulations (10 CFR 1004) require DOE to release certain documents and records regarding grants to any person who provides a written request. The intended use of the information will not be a criterion for release. These requirements apply to information held by DOE and do not require grantees, their subgrantees, or their contractors to permit public access to their records.

b. Records maintained by DOE with respect to grants are subject to the provisions of the Privacy Act and the DOE implementing regulations (10 CFR 1008) if those records constitute a "system of records" as defined in the Act and the regulations. Generally, records maintained by grantees, their subgrantees, or their contractors are not subject to these requirements.

21. ACKNOWLEDGMENT OF SUPPORT. Publication of the results of the grant is encouraged subject to any applicable restrictions in 10 CFR 600.33 (Patents, Data, and Copyrights). Any article published shall include an acknowledgment that the research was supported, in whole or in part, by a DOE grant (with the grant number) and a statement that such support does not constitute an endorsement by DOE of the views expressed in the article.

22. NATIONAL SECURITY.

a. It is not expected that activities under the grant will generate or otherwise involve classified information (i.e., Restricted Data, Formerly Restricted Data, National Security Information).

b. However, if in the opinion of the grantee or DOE such involvement becomes expected prior to the closeout of the grant, the grantee or DOE shall notify the other in writing immediately. If the grantee believes any information developed or acquired may be classifiable, the grantee shall not provide the potentially classifiable information to anyone, including the DOE officials with whom the grantee normally communicates, except the Director of Classification, and shall protect such information as if it were classified until notified by DOE that a determination has been made that it does not require such handling. Correspondence which includes the specific information in question shall be sent by registered mail to U.S. Department of Energy, ATTN: Director of Classification, DP-32, Washington, DC 20585. If the information is determined to be classified, the grantee may wish to discontinue the project, in which case the grantee and DOE shall terminate the grant by mutual agreement. If the grant is to be terminated, all material deemed by DOE to be classified shall be forwarded to DOE, in a manner specified by DOE, for proper disposition. If the awardee and DOE wish to continue the award, even though classified information is involved, the grantee shall be required to obtain both personnel and facility security clearances through the Office of Safeguards and Security for Headquarters awarded grants or from the cognizant field office Division of Safeguards and Security for grants obtained through DOE field organizations. Costs associated with handling and protecting any such classified information shall be negotiated at the time the determination to proceed is made.

23. SUSPENSIONS AND TERMINATIONS.

a. Under the provisions of 10 CFR 600.29 and 600.121, DOE may suspend or terminate the award, in whole or in part, (1) when DOE believes that the grantee has materially failed to comply with the terms and conditions of the award, (2) for any reason by mutual agreement between DOE and the grantee upon the request of either party, or (3) when the parties cannot mutually agree to the extent of a termination.

b. Normally, DOE action to suspend or terminate an award for cause will be taken only after DOE has informed the grantee of any deficiency on its part and given an opportunity to correct it. However, DOE may immediately suspend or terminate the award without prior notice when it believes such action is necessary to protect the interests of the Government.

c. No costs incurred during a suspension period or after the effective date of a termination will be allowable, except those costs which, in the opinion of DOE, the grantee could not reasonably avoid or eliminate or which were otherwise authorized by the suspension or termination notice, provided such costs would otherwise be allowable under the terms of the award and the applicable Federal cost principles.

d. Final allowable costs under a termination settlement shall be in accordance with the terms of the award, including this term, and the appropriate Federal cost principles. In no event will the total of payments under a terminated award exceed the amount obligated by DOE or the DOE pro rata share when cost-sharing was required, whichever is less.

e. Within 90 days after the termination of the grant, the grantee shall submit any final financial, performance, and other reports required by the terms and conditions of the award. (See 10 CFR 600.115 and 600.116).

f. A notice of termination for cause may be subject to review according to the provisions of 10 CFR 600.26, Disputes and Appeals.

24. INTEREST.

a. Notwithstanding any other term or condition of the grant/cooperative agreement, all amounts that become payable by the recipient to the Government under the grant/cooperative agreement shall bear simple interest from the date due until paid unless paid within 30 days of becoming due. The interest rate shall be the interest rate established by the Secretary of the Treasury (Secretary) as provided in section 11 of the Debt Collection Act of 1982 (31 U.S.C. 3717), which is applicable to the period in which the amount becomes due, as provided in paragraph b. below, and then at the rate applicable for each 3-month period as fixed by the Secretary until the amount is paid.

b. Amounts shall be due at the earliest of the following dates:

(1) The date fixed under the grant/cooperative agreement.

(2) The date of the first written demand for payment consistent with the grant/cooperative agreement, including any demand resulting from a termination.

(3) The date the Government transmits to the recipient a proposed agreement to confirm completed negotiations establishing the amount of debt.

c. The interest charge made under this provision may be reduced in accordance with the procedures prescribed in 4 CFR 102.13 or in accordance with agency regulations in effect on the date of original award of the grant/cooperative agreement.

25. FOREIGN TRAVEL.

Foreign travel is any travel outside Canada and the United States and its territories and possessions or, for grantees located in another country, travel outside that country. The International Air Transportation Fair Competitive Practices Act of 1974 (49 USC 1517) (Fly America Act) requires Federal grantees to use U.S. flag carriers for Government-financed international air travel to the extent these carriers are available. Grantees contemplating the use of non-U.S. flag carriers should consult with the DOE contracting officer prior to the trip.

APPENDIX B

INTELLECTUAL PROPERTY PROVISIONS

ARTICLE	TITLE	PAGE NO.
1	Authorization and Consent	2
2	Notice and Assistance Regarding Patent and Copyright Infringement	2
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Attachment 1	Patent Rights - Small Business Firms or Nonprofit Organizations (Other than GOCO's) - SBNP-987	

GPNSB-987 (MODIFIED - ARC)

ARTICLE 1. AUTHORIZATION AND CONSENT

The Government hereby gives its authorization and consent for all use and manufacture of any invention described in and covered by a patent of the United States in the performance of this contract or any part hereof or any amendment hereto or any subcontract hereunder (including all lower-tier subcontracts).

ARTICLE 2. NOTICE AND ASSISTANCE REGARDING PATENT AND COPYRIGHT INFRINGEMENT

The provisions of this clause shall be applicable only if the amount of this grant exceeds $10,000.

(a) The Grantee shall report to the Contracting Officer, promptly and in reasonable written detail, each notice of claim of patent or copyright infringement based on the performance of this grant of which the Grantee has knowledge.

(b) In the event of any claim or suit against the Government on account of any alleged patent or copyright infringement arising out of the performance of this grant or out of the use of any supplies furnished or work or services performed hereunder, the Grantee shall furnish to the Government, when requested by the Contracting Officer, all evidence and information in possession of the Grantee pertaining to such suit or claim. Such evidence and information shall be furnished at the expense of the Government except where the Grantee has agreed to indemnify the Government.

(c) This clause shall be included in all contracts and subgrants under this grant.

ARTICLE 3. REPORTING OF ROYALTIES

If this grant is in an amount which exceeds $10,000 and if any royalty payments are directly involved in the grant or are reflected in the grant price to the Government, the Grantee agrees to report in writing to the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) during the performance of this grant and prior to its completion or final settlement the amount of any royalties or other payments paid or to be paid by it directly to others in connection with the performance of this grant together with the names and addresses of licensors to whom such payments are made and either the patent numbers involved or such other information as will permit the identification of the patents or other basis on which the royalties are to be paid. The approval of DOE of any individual payments or royalties shall not stop the Government at any time from contesting the enforceability, validity or scope of, or title to, any patent under which a royalty or payments are made.

ARTICLE 4. ADVANCE WAIVER OF PATENT RIGHTS

(a) Definitions.

(1) "Subject Invention" means any invention or discovery of the Grantee conceived or first actually reduced to practice in the course of or under this grant and includes any art, method, process, machine, manufacture, design, or composition of matter, or any new and useful improvement thereof, or any variety of plants, whether patented or unpatented under the Patent Laws of the United States of America or any foreign country.

(2) "Contract" means any contract, grant, agreement, understanding, or other arrangement, which includes research, development, or demonstration work, and includes any assignment or substitution of parties.

(3) "Government agency" includes an executive department, independent commission, board, office, agency, administration, authority, Government corporation, or other Government establishment of the Executive Branch of the Government of the United States of America.

(4) "To the point of practical application" means to manufacture in the case of a composition or product, to practice in the case of a process, or to operate in the case of a machine and under such conditions as to establish that the invention is being worked and that its benefits are reasonably accessible to the public.

(5) "Patent Counsel" means the DOE Patent Counsel assisting the procuring activity.

(b) Allocation of principal rights.

(1) Assignment to the Government. The Contractor agrees to assign to the Government the entire right, title, and interest throughout the world in and to each Subject Invention, except to the extent that rights are waived to and retained by the Grantee under paragraphs (b)(2) and (c) of this clause.

(2) Greater rights determinations. The Grantee or the employee-inventor with authorization of the Grantee may request greater rights than the domestic and foreign patent rights provided in paragraph (c) of this clause on identified inventions in accordance with 41 CFR 9-9.109-6. Such requests must be submitted to Patent Counsel (with notification by Patent Counsel to the Contracting Officer) at the time of the first disclosure pursuant to paragraph (e)(2) of this clause, or not later than 9 months after conception or first actual reduction to practice, whichever occurs first, or such longer period as may be authorized by Patent Counsel (with notification by Patent Counsel to the Contracting Officer) for good cause shown in writing by the Grantee.

(c) Rights to the Grantee.

(1) Minimum Grantee license. The Grantee reserves an irrevocable, nonexclusive, paid-up license in each patent application filed in any country on a Subject Invention and any resulting patent in which the Government acquires title. The license shall extend to the Grantee's domestic subsidiaries and affiliates, if any, within the corporate structure of which the Grantee is a part and shall include the right to grant sublicenses of the same scope to the extent the Grantee was legally obligated to do so at the time the contract was awarded. The license shall be transferable only with approval of DOE except when transferred to the successor of that part of the Grantee's business to which the invention pertains.

(2) Election to retain waived rights.

(i) Subject to the provisions of paragraph (c)(3) and paragraph (d) of this clause, with respect only to a Subject Invention reported in accordance with paragraph (e)(2)(i) of this clause and with the written report of which is included an election as to whether the Grantee will retain the rights in the invention waived therein, the Grantee reserves the entire domestic right, title and interest in any United States patent application on the Subject Invention filed and any resulting United States patent secured by the Grantee.

(ii) Subject to the provisions of paragraph (c)(3) and paragraph (d) of this clause, with respect only to a Subject Invention reported in accordance with paragraph (e)(2)(i) of this clause and with the written report of which is included an election as to whether the Grantee will retain the rights in the invention waived herein and a statement specifying those foreign countries in which such rights will be retained, and subject to DOE security regulations and requirements, the Grantee reserves the entire right, title and interest in any foreign patent application on the Subject Invention filed and any resulting foreign patent secured by the Contractor in those foreign countries specified.

(3) Terms and Conditions of Waived Rights.

(i) Subject to the rights granted in paragraph (c)(1) of this clause, the Grantee agrees to convey to the Government, upon request, the entire domestic right, title, and interest in any Subject Invention when the Grantee:

(A) Does not elect pursuant to paragraph (c)(2)(i) of this clause to retain such rights;

(B) Fails to have a United States patent application filed on the invention in accordance with paragraph (d)(1) of this clause, or decides not to continue prosecution of such application; or

(C) At any time, no longer desires to retain title.

(ii) Subject to the rights granted in paragraph (c)(1) of this clause, the Grantee agrees to convey to the Government, upon request, the entire right, title, and interest in any Subject Invention in any foreign country if the Grantee:

(A) Does not elect pursuant to paragraph (c)(2)(ii) of this clause to retain such rights in the country; or

(B) Fails to have a patent application filed in the country on the Subject Invention in accordance with paragraph (d)(3) of this clause, or decides not to continue prosecution or to pay any maintenance fees covering the invention. To avoid forfeiture of the patent application or patent, the Grantee shall notify the Patent Counsel not less than 60 days before the expiration period for any action required by the foreign Patent Office.

(iii) Conveyance requested pursuant to paragraphs (c)(3)(i) and (c)(3)(ii) of this clause shall be made by delivering to the Patent Counsel duly executed instruments and such other papers as are deemed necessary to vest in the Government the entire right, title, and interest in the invention to enable the Government to apply for and prosecute patent applications covering the invention in this or the foreign country, respectively, or otherwise establish its ownership of the invention.

(iv) For each invention in which the Grantee initially elects pursuant to (c)(2)(i) or (c)(2)(ii) of this clause not to retain the rights waived, the Grantee shall inform the Patent Counsel promptly in writing of the date and identity of any on sale, public use, or public disclosure of the invention which may constitute a statutory bar under 35 USC 102, which was authorized by or known to the Grantee or any contemplated action of this nature.

(v) Government License

With respect to any Subject Invention in which the Grantee retains title, the Federal Government shall have a nonexclusive, nontransferable, irrevocable, paid-up license to practice or have practiced for or on behalf of the United States the Subject Invention throughout the world.

(vi) Reporting on Utilization of Subject Inventions

The Grantee agrees to submit on request periodic reports no more frequently than annually on the utilization of a Subject Invention or on efforts at obtaining such utilization that are being made by the Grantee or its licensees or assignees. Such reports shall include information regarding the status of development, date of first commercial sale or use, gross royalties received by the Grantee and such other data and information as DOE may reasonably specify. The

Grantee also agrees to provide additional reports as may be requested by DOE in connection with any march-in proceeding undertaken by DOE in accordance with paragraph (c)(3)(viii) of this clause. To the extent data or information supplied under this paragraph is considered by the Contractor, its licensee or assignee to be privileged and confidential and is so marked, DOE agrees that, to the extent permitted by 35 USC 202(c)(5), it will not disclose such information to persons outside the Government.

(vii) Preference for United States Industry

Notwithstanding any other provision of this clause, the Grantee agrees that neither it nor any assignee will grant to any person the exclusive right to use or sell any Subject Invention in the United States unless such person agrees that any products embodying the Subject Invention or produced through the use of the Subject Invention will be manufactured substantially in the United States. However, in individual cases, the requirement for such an agreement may be waived by DOE upon a showing by the Grantee or its assignee that reasonable but unsuccessful efforts have been made to grant licenses on similar terms to potential licensees that would be likely to manufacture substantially in the United States or that under the circumstances domestic manufacture is not commercially feasible.

In the event that a subcontractor has a waiver or modification of this provision through a previous government contract than the terms and conditions of that contract will control. In no event will this provision provide greater rights than those of the previously waived or modified provisions.

(viii) March-in Rights

The Grantee agrees that with respect to any Subject Invention in which it has acquired title, DOE has the right in accordance with the procedures in 37 CFR 401.6 and any supplemental regulations of DOE to require the Grantee, Subcontractor, an assignee, or exclusive licensee of a Subject Invention to grant a nonexclusive, partially exclusive, or exclusive license in any field of use to a responsible applicant or applicants, upon terms that are reasonable under the circumstances, and if the Contractor, assignee, or exclusive licensee refuses such a request, DOE has the right to grant such a license itself if DOE determines that:

(1) Such action is necessary because the Grantee or assignee has not taken, or is not expected to take within a reasonable time, effective steps to achieve practical application of the Subject Invention in such field of use;

(2) Such action is necessary to alleviate health or safety needs which are not reasonably satisfied by the Grantee, assignee, or their licensees;

(3) Such action is necessary to meet requirements for public use specified by federal regulations and such requirements are not reasonably satisfied by the Grantee, assignee, or licensees; or

(4) Such action is necessary because the agreement required by paragraph (c)(3)(vii) of this clause has not been obtained or waived or because a licensee of the exclusive right to use or sell any Subject Invention in the United States is in breach of such agreement.

(ix) Waiver To Subcontractors and U.S. Competitiveness

Grantee shall include in all subcontracts patent and data provisions consistent with the terms and conditions of the patent waiver and data determination to the Grantee under this agreement. Prior to any subcontract being effective, the Grantee shall notify the Contracting Officer of the Subcontractors' assent to the patent and data rights determinations either by (i) giving written notice that it accepts such terms or (ii) providing an executed copy of the subcontract. As provided in those documents, it is expected that after negotiations conducted by the Grantee, the patent and data rights disposition shall be passed on to the Subcontractors selected under Phase 2 on terms and conditions agreeable to the Grantee and the Subcontractor. In addition, Grantee shall include as a minimum the provisions of U.S. Competitiveness provisions of any other preexisting government contract, if any, entered into by the Subcontractor in the subject technology. Grantee is free to negotiate greater rights to promote U.S. competitiveness.

(4) Terminations.

(i) Any waiver or retention of rights by the Grantee under paragraphs (b)(2), (c)(1), or (c)(2) of this clause may be terminated at the discretion of the Secretary or his designee, in whole or in part, if the request for waiver or retention of rights by the Grantee is found to contain false material statements or nondisclosure of material facts, and such were specifically relied upon in reaching the waiver determination or the agreement to the retention of rights by the Grantee.

(ii) Any waiver of the rights retained in accordance with paragraph (c)(2), as applied to particular inventions, may be terminated at the discretion of the Secretary or his designee, in whole or in part, if the Grantee fails to comply with the provisions set forth in paragraph (c)(3) and paragraph (d) of this clause, and such failure is determined by the Secretary or his designee to be material and detrimental to the interests of the United States and the general public.

(iii) Prior to terminating any waiver of rights under paragraph (c)(4)(i) or (c)(4)(ii) of this clause, the Grantee will be given written notice of the intention to terminate the waiver of rights, the extent of such proposed termination and the reasons therefor, and a period of 30 days, or such longer period as the Secretary or his designee shall determine for good cause shown in writing, to show cause why the waiver of rights should not be so terminated.

(iv) All terminations of waivers of rights under paragraph (c)(4)(ii) shall be subject to the rights granted in paragraph (c)(1) of this clause, and termination shall normally be partial in nature, requiring the Grantee to grant nonexclusive or partially exclusive licenses to responsible applicants upon terms reasonable under the circumstances.

(5) Effective Date of Waivers.

The waiver of rights in a Subject Invention shall be effective on the following dates:

(i) For advance waivers of identified inventions, i.e., inventions conceived prior to the effective date of the contract, on the effective date of the contract even though the advance waiver may have been requested after that date;

(ii) For identified inventions under advance waivers, i.e., inventions conceived or first actually reduced to practice after the effective date of the contract, on the date the invention is reported with the election to retain the waived rights in that invention; and

(iii) For waivers of identified inventions (other than under an advance waiver), on the date of the letter notifying the requestor that the waiver has been granted.

(d) Filing of patent applications.

(1) With respect to each Subject Invention in which the Grantee elects to retain domestic rights pursuant to paragraph (c)(2)(i) of this clause, the Grantee shall have a domestic patent application filed on the invention within 6 months after submission of the invention disclosure pursuant to paragraph (e)(2)(i) of this clause, or such longer period of time as may be approved by the Patent Counsel for good cause shown in writing by the Grantee for each identified invention, the rights in which are waived to the Grantee, the Grantee shall have a domestic patent application filed on the invention within 6 months after the waiver has become effective. With respect to the invention, the Grantee shall promptly notify the Patent Counsel of any decision not to file an application.

(2) For each Subject Invention on which a domestic patent application is filed by the Grantee, the Grantee shall:

(i) Within 2 months after the filing or within 2 months after submission of the invention disclosure if the patent application previously has been filed, deliver to Patent Counsel a copy of the application as filed including the filing date and serial number;

(ii) Within 6 months after filing the application or within 6 months after submitting the invention disclosure if the application has been filed previously, deliver to the Patent Counsel a duly executed and approved instrument fully confirmatory of all rights to which the Government is entitled, and provide DOE an irrevocable power to inspect and make copies of the patent application filed;

(iii) Provide the Patent Counsel with a copy of the patent within 2 months after a patent is issued on the application;

(iv) Not less than 30 days before the expiration of the response period for any action required by the Patent and Trademark Office, notify the Patent Counsel of any decision not to continue prosecution of the application and deliver to the Patent Counsel executed instruments granting the Government a power of attorney; and

(v) Include the following statement in the second paragraph of the specification of the application and any patents issued on a Subject Invention, "The Government of the United States of America has rights in this invention pursuant to Contract No. ____________________ (or Grant No. ____________) awarded by the U.S. Department of Energy".

(3) With respect to each Subject Invention in which the Grantee has elected pursuant to paragraph (c)(2)(ii) of this clause to retain the patent rights waived in specified foreign countries, or in which the Grantee has obtained a waiver of foreign rights on an identified invention:

(i) The Grantee shall file a patent application on the invention in each specified foreign country in accordance with applicable statutes and regulations and within one of the following periods:

(A) Eight months from the date of filing a corresponding United States application, or if such an application is not filed, six months from the date the invention is submitted in a disclosure pursuant to paragraph (e)(2)(i) of this clause;

(B) Six months from the date a license is granted by the Commissioner of Patents and Trademarks to file the foreign patent application where such filing has been prohibited by security reasons; or

(C) Such longer period as may be approved by the Patent Counsel for good cause shown in writing by the Contractor.

(ii) The Grantee shall notify the Patent Counsel promptly of each foreign application filed and upon written request shall furnish an English version of the application without additional compensation.

(e) Invention identification, disclosures, and reports.

(1) The Grantee shall establish and maintain active and effective procedures to ensure that Subject Inventions are promptly identified and timely disclosed. Those procedures shall include the maintenance of laboratory notebooks or equivalent records and any other records that are reasonably necessary to document the conception and/or the first actual reduction to practice of subject Inventions, and records which show that the procedures for identifying and disclosing the inventions are followed. Upon request, the Grantee shall furnish the Contracting Officer a description of these procedures so that he may evaluate and determine their effectiveness.

(2) The Grantee shall furnish the Patent Counsel (with notification by Patent Counsel to the Contracting Office) on a DOE-approved form:

(i) A written report containing full and complete technical information concerning each Subject Invention within 6 months after conception or first actual reduction to practice whichever occurs first in the course of or under this contract, but in any event prior to any on sale, public use or public disclosure of such inventions known to the Grantee. The report shall identify the contract and inventor and shall be sufficiently complete in technical detail and appropriately illustrated by sketch or diagram to convey to one skilled in the art to which the invention pertains a clear understanding of the nature, purpose, operation, and to the extent known, the physical, chemical, biological, or electrical characteristics of the invention. The report should also include any election of foreign patent rights under paragraph (c)(2)(ii) of this clause and any election of rights under paragraph (c)(2)(i) of this clause. Any requests for greater rights shall be made within the period set forth in paragraph (b)(2) of this clause. When an invention is reported under this paragraph (e)(2)(i), it shall be presumed to have been made in the manner specified in Section (a)(1) and (2) of 42 USC 5908 unless the Grantee contends it was not so made in accordance with paragraph (g)(2)(ii) of this clause.

(ii) Upon request, but not more than annually, interim reports on a DOE-approved form listing Subject Inventions and subcontracts awarded containing a Patent Rights clause for that period and certifying that:

(A) The Grantee's procedures for identifying and disclosing Subject Inventions as required by this paragraph (e) have been followed throughout the reporting period;

(B) All Subject Inventions have been disclosed or that there are no such inventions;

(C) All subcontracts containing a Patent Rights clause have been reported or that no such subcontracts have been awarded; and

(iii) A final report on a DOE-approved form within 3 months after completion of the contract work listing all Subject Inventions and all subcontracts awarded containing a Patent Rights clause and certifying that:

(A) All Subject Inventions have been disclosed or that there were no such inventions; and

(B) All subcontracts containing a Patent Rights clause have been reported or that no such subcontracts have been awarded.

(3) The Grantee shall obtain patent agreements to effectuate the provisions of this clause from all persons in its employ who perform any part of the work under this contract except nontechnical personnel, such as clerical employees and manual laborers.

(4) The Grantee agrees that the Government may duplicate and disclose Subject Invention disclosures and all other reports and papers furnished or required to be furnished pursuant to this clause. If the Grantee is to file a foreign patent application on a Subject Invention, the Government agrees, upon written request, to use its best efforts to withhold publication of such invention disclosures until the expiration of the time period specified in paragraph (d)(1) of this clause, but in no event shall the Government or its employees be liable for any publication thereof.

(f) Publication.

It is recognized that during the course of the work under this contract, the Grantee or its employees may from time to time desire to release or publish information regarding scientific or technical developments conceived or first actually reduced to practice in the course of or under this contract. In order that public disclosure of such information will not adversely affect the patent interests of DOE or the Grantee, patent approval for release or publication shall be secured from Patent Counsel prior to any such release or publication.

(g) Forfeiture of rights in unreported Subject Inventions.

(1) The Grantee shall forfeit to the Government, at the request of the Secretary or his designee, all rights in any Subject Invention which the Grantee fails to report to Patent Counsel (with notification by Patent Counsel to the Contracting Officer) within six months after the time the Grantee:

(i) Files or causes to be filed a United States or foreign patent application thereon; or

(ii) Submits the final report required by paragraph (e)(2)(ii) of this clause, whichever is later.

(2) However, the Grantee shall not forfeit rights in a Subject Invention if, within the time specified in (1)(i) or (1)(ii) of this paragraph (g), the Grantee:

(i) Prepared a written decision based upon a review of the record that the invention was neither conceived nor first actually reduced to practice in the course of or under the contract and delivers the same to Patent Counsel (with notification by Patent Counsel to the Contracting Officer); or

(ii) Contending that the invention is not a Subject Invention the Grantee nevertheless discloses the invention and all facts pertinent to this contention to the Patent Counsel (with notification by Patent Counsel to the Contracting Officer); or

(iii) Establishes that the failure to disclose did not result from the Grantee's fault or negligence.

(3) Pending written assignment of the patent applications and patents on a Subject Invention determined by the Secretary or his designee to be forfeited (such determination to be a final decision under the Disputes Clause of this contract), the Grantee shall be deemed to hold the invention and the patent applications and patents pertaining thereto in trust for the Government. The forfeiture provision of this paragraph (g) shall be in addition to and shall not supersede other rights and remedies which the Government may have with respect to Subject Invention.

(h) Examination of records relating to inventions.

(1) The Contracting Officer or his authorized representative, until the expiration of 3 years after final payment under this contract, shall have the right to examine any books (including laboratory notebooks), records, documents, and other supporting data of the Grantee which the Contracting Officer or his authorized representative reasonably deem pertinent to the discovery or identification of Subject Inventions or to determine compliance with the requirements of this clause.

(2) The Contracting Officer or his authorized representative shall have the right to examine all books (including laboratory notebooks), records and documents of the Grantee relating to the conception or first actual reduction to practice of inventions in the same field of technology as the work under this contract to determine whether any such inventions are Subject Inventions, if the Grantee refuses or fails to:

(i) Establish the procedures of paragraph (e)(1) of this clause; or

(ii) Maintain and follow such procedures; or

(iii) Correct or eliminate any material deficiency in the procedures within thirty (30) days after the Contracting Officer notifies the Grantee of such a deficiency.

(i) Withholding of payment (not applicable to subcontracts).

(1). Any time before final payment of the amount of this contract, the Contracting Officer may, if he deems such action warranted, withhold payment until a reserve not exceeding $50,000 or 5 percent of the amount of this contract, whichever is less, shall have been set aside if in his opinion the Grantee fails to:

(i) Establish, maintain and follow effective procedures for identifying and disclosing Subject Inventions pursuant to paragraph (e)(1) of this clause; or

(ii) Disclose any Subject Invention pursuant to paragraph (e)(2)(i) of this clause; or

(iii) Deliver the interim reports pursuant to paragraph (e)(2)(ii) of this clause; or

(iv) Provide the information regarding subcontracts pursuant to paragraph (j)(5) of this clause; or

(v) Convey to the Government in a DOE-approved form the title and/or rights of the Government in each Subject Invention as required by this clause.

(2) The reserve or balance shall be withheld until the Contracting Officer has determined that the Grantee has rectified whatever deficiencies exist and has delivered all reports, disclosures, and other information required by this clause.

(3) Final payment under this contract shall not be made by the Contracting Officer before the Grantee delivers to Patent Counsel all disclosures of Subject Inventions and other information required by

(e)(2)(i) of this clause, the final report required by (e)(2)(iii) of this clause, and Patent Counsel has issued a patent clearance certification to the Contracting Officer.

(4) The Contracting Officer may, in his direction, decrease or increase the sums withheld up to the maximum authorized above. If the Grantee is a nonprofit organization, the maximum amount that may be withheld under this paragraph shall not exceed $50,000 or 1 percent of the amount of this contract, whichever is less. No amount shall be withheld under this paragraph while the amount specified by this paragraph is being withheld under other provisions of the contract. The withholding of any amount or subsequent payment thereof shall not be construed as a waiver of any rights accruing to the Government under this contract.

(j) Subcontracts.

(1) For the purpose of this paragraph the term "Contractor" means the party awarding a subcontract and the term "Subcontractor" means the party being awarded a subcontract, regardless of tier.

(2) The Contractor will include the Patent Rights clause of DEAR 952.227-71 suitably modified to identify the parties in all subcontracts, regardless of tier, for experimental, developmental or research work to be performed by a small business or a domestic nonprofit organization. In all other subcontracts, regardless of tier, for experimental, developmental demonstration, or research work, the Contractor shall include the Patent Rights article of 41 CFR 9-9.107-5(a) or 41 CFR 9-9.107-6 as appropriate, modified to identify the parties.

(3) Except as may be otherwise provided in this clause, the Contractor shall not, in any subcontract or by using a subcontract as consideration therefor, acquire any rights in its subcontractor's Subject Invention for the Contractor's own use (as distinguished from such rights as may be required solely to fulfill the Contractor's contract obligations to the Government in the performance of this contract).

(4) All invention disclosures, reports, instruments, and other information required to be furnished by the Subcontractor to DOE, under the provisions of a Patent Rights clause in any subcontract hereunder may, in the discretion of the Contracting Officer, be furnished to the Contractor for transmission to DOE.

(5) The Contractor shall promptly notify the Contracting Officer in writing upon the award of any subcontract containing a Patent Rights clause by identifying the Subcontractor, the work to be performed under the subcontract, and the dates of award, and estimated completion. Upon the request of the Contracting Officer the Contractor shall furnish him a copy of the subcontract.

(6) The Contractor shall identify all Subject Inventions of the Subcontractor of which it acquires knowledge in the performance of this contract and shall notify the Patent Counsel (with notification by Patent Counsel to the Contracting Officer) promptly upon the identification of the inventions.

(7) It is understood that the Government is a third party beneficiary of any subcontract clause granting rights to the Government in Subject Inventions, and the Contractor hereby assigns to the Government all rights that the Contractor would have to enforce the Subcontractor's obligations for the benefit of the Government with respect to Subject Inventions. The Contractor shall not be obligated to enforce the agreements of any Subcontractor hereunder relating to the obligations of the Subcontractor to the Government regarding Subject Inventions.

(k) Background Patents.

(1) "Background Patent" means a domestic patent covering an invention or discovery which is not a Subject Invention and which is owned or controlled by the Grantee at any time through the completion of this contract:

(i) Which the Grantee but not the Government, has the right to license to others without obligation to pay royalties thereon, and

(ii) Infringement of which cannot reasonably be avoided upon the practice of any specific process, method, machine, manufacture or composition of matter (including relatively minor modifications thereof) which is a subject of the research, development, or demonstration work performed under this contract.

(2) The Grantee agrees to and does hereby grant to the Government a royalty-free, nonexclusive license under any Background Patent for purposes of practicing a subject of this contract by or for the Government in research, development, and demonstration work only.

(3) The Grantee also agrees that upon written application by DOE, it will grant to responsible parties for purposes of practicing a subject of this contract nonexclusive licenses under any Background Patent on terms that are reasonable under the circumstances. If, however, the Grantee believes that exclusive or partially exclusive rights are necessary to achieve expeditious commercial development or utilization, then a request may be made to DOE for DOE approval of such licensing by the Grantee.

(4) Notwithstanding the foregoing paragraph (k)(3), the Contractor shall not be obligated to license any Background Patent if the Grantee demonstrates to the satisfaction of the Secretary or his designee that:

(i) a competitive alternativa to the subject matter covered by said Background Patent is commercially available or readily introducible from one or more other sources; or

(ii) the Grantee or its licensees are supplying the subject matter covered by said Background Patent in sufficient quantity and at reasonable prices to satisfy market needs, or have taken effective steps or within a reasonable time are expected to take effective steps to so supply the subject matter.

(5) The Grantee shall include in all subcontracts the provisions of this paragraph sufficiently modified to conform with any other preexisting government contract entered into by the Subcontractor requiring Background Patent rights in the existing technology.

(l) Atomic Energy.

(1) No claim for pecuniary award or compensation under the provisions of the Atomic Energy Act of 1954, as amended, shall be asserted by the Contractor or its employees with respect to any invention or discovery made or conceived in the course of or under this contract.

(2) Except as otherwise authorized in writing by the Contracting Officer, the Grantee will obtain patent agreements to effectuate the provisions of paragraph (l)(1) of this clause from all persons who perform any part of the work under this contract, except nontechnical personnel, such as clerical employees and manual laborers.

(m) Limitation of rights.

Nothing contained in this Patent Rights clause shall be deemed to give the Government any rights with respect to any invention other than a subject invention except as set forth in the Patent Rights clause of this contract with respect to Background Patents.

ARTICLE 5. ADDITIONAL TECHNICAL DATA REQUIREMENTS

(a) In addition to the technical data specified elsewhere in this grant to be delivered, such as in Appendix A, paragraph 8 and in Appendix D-2 (program deliverables) the Contracting Officer with mutual agreement of the Grantee may at any time during the grant performance or within one year after final payment call for the Grantee to deliver any technical data first produced or specifically used in the performance of this grant except technical data pertaining to items of standard commercial design.

(b) The provisions of the Rights in Technical Data clause included in this grant are applicable to all technical data called for under this Additional Technical Data Requirements clause. Accordingly, nothing contained in this clause shall require the Grantee to actually deliver any technical data, the delivery of which is excused by paragraph (e) of the Rights in Technical Data clause.

(c) When technical data are to be delivered under this clause, the Grantee will be compensated for appropriate costs for converting such data into the prescribed form, for reproduction, and for delivery.

ARTICLE 6. RIGHTS IN TECHNICAL DATA

(a) Definitions.

(1) "Technical Data" means recorded information regardless of form or characteristic, of a scientific or technical nature. It may, for example, document research, experimental, developmental, or demonstration, or engineering work, or be usable or used to define a design or process, or to procure, produce, support, maintain, or operate material. The data may be graphic or pictorial delineations in media such as drawings or photographs, text in specifications or related performance or design type documents or computer software (including computer programs, computer software data bases, and computer software documentation). Examples of technical data include research and engineering data, engineering drawings and associated lists. specifications, standards, process sheets, manuals, technical reports, catalog item identification, and related information. Technical data as used herein does not include financial reports, cost analyses, and other information incidental to contract administration.

(2) "Proprietary Data" means technical data which embody trade secrets developed at private expense, such as design procedures or techniques, chemical composition of materials, or manufacturing methods, processes, or treatments, including minor modifications thereof, provided that such data:

(i) Are not generally known or available from other sources without obligation concerning this confidentiality;

(ii) Have not been made available by the owner to others without obligation concerning their confidentiality; and

(iii) Are not already available to the Government without obligation concerning their confidentiality.

(3) "Grant Data" means technical data first produced in the performance of the grant, technical data which are specified to be delivered in the grant, technical data that may be called for under the "Additional Technical Data Requirements" article of the grant, if any, or technical data actually delivered in connection with the grant.

(4) "Unlimited Rights" means rights to use, duplicate, or disclose technical data, in whole or in part, in any manner and for any purpose whatsoever, and to permit others to do so.

(5) "Limited rights data," as used in this clause, means data developed at private expense that embody trade secrets or are commercial or financial and confidential or privileged.

(6) "Limited rights," as used in this clause, means the rights of the Government in limited rights data as set forth in the Limited Rights Notice of subparagraph (g)(2) if included in this clause.

(b) Allocation of rights.

(1) The Government shall have:

(i) Unlimited rights in grant data except as otherwise provided below with respect to proprietary data.

(ii) The right to remove, cancel, correct or ignore any markings not authorized by the terms of this grant on any technical data furnished hereunder, if in response to a written inquiry by DOE concerning the propriety of the markings, the Grantee fails to respond thereto within 60 days or fails to substantiate the propriety of the markings. In either case DOE will notify the Grantee of the action taken.

(iii) No rights under this grant in any technical data which are not grant data.

(2) The Grantee shall have:

(i) The right to withhold proprietary data in accordance with the Provisions of this article,

(ii) The right to use for its private purposes, subject to patent, security or other provisions of this grant, grant data it first produces in the performance of this grant provided the data requirements of this grant have been met as of the date of the Private use of such data. The Grantee agrees that to the extent it receives or is given access to proprietary data or other technical, business or financial data in the form of recorded information from DOE or a DOE grant, contract or subcontractor, the Grantee shall treat such data in accordance with any restrictive legend contained thereon, unless use is specifically authorized by prior written approval of the Contracting Officer.

(iii) The right to protect from unauthorized disclosure and use those data which are limited rights data to the extent provided in paragraph (g) below, and

(iv) The right to establish claim to copyright subsisting in data first produced in the performance of this grant to the extent provided in subparagraph (c)(1) below.

(c) Copyrighted material.

(1) Data first produced in the performance of this grant. Unless provided otherwise in subparagraph (d) below, the Grantee may establish, without prior approval of the Contracting Officer, claim to copyright subsisting in all technical data first produced in the performance of this contract. When claim to copyright is made, the Grantee shall affix the applicable copyright notices of 17 U.S.C. 401 or 402 and acknowledgement of Government sponsorship (including Grant number) to the data when such data are delivered to the Government, as well as when the data are published or deposited for registration as a published work in the U.S. Copyright Office. For technical data including computer software, the Grantee grants to the Government, and others acting on its behalf, a paid-up nonexclusive, irrevocable worldwide license in such copyrighted data to reproduce, prepare derivative works, distribute copies to the public, and perform publicly and display publicly, and to permit others to do so. At the time permission to assert copyright is granted by DOE, the above recited license shall be effective as to works already in existence and will vest in future works at the time of their creation subject to the delayed release provisions of subparagraph (d)(4) below.

(2) Data not first produced in performance of this grant. The Grantee agrees not to include in the technical data delivered under the grant any copyrighted material not first produced in performance of this grant unless the Grantee identifies such data and grants to the government, or acquires on its behalf at no cost, a license therein for the benefit of the Government of the same scope as set forth in paragraph (c)(1) above. If such royalty-free license is unavailable and the Grantee nevertheless determines that such copyrighted material must be included in the technical data to be delivered, rather than merely incorporated therein by reference, the Grantee shall request the written authorization of the Grants Officer to include such copyrighted material in the technical data without a license.

(3) The terms and conditions of subparagraph (c)(1) above shall not be included in subcontracts without the prior written approval of the Contracting Officer.

(d) Release, publication and use of data.

(1) The Grantee shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Grantee in the performance of this grant except to the extent such data may be subject to the Federal export control or national security laws or regulations, or unless otherwise

provided below in this paragraph or expressly set forth in this grant and restricted from public release by DOE pursuant to paragraph (d)(4) below. Grantee shall have the right to license any data first produced in the performance of this grant.

(2) The Grantee agrees that to the extent it receives or is given access to data necessary for the performance of this grant which contain restrictive markings, the Grantee shall treat the data in accordance with such markings unless otherwise specifically authorized in writing by the Contracting Officer.

(3) Where the Grantee has exercised claim to copyright in computer software in accordance with subparagraph (c) (1), the Grantee shall give notice of such claim to the Contracting Officer who shall specify appropriate terms to assure dissemination of the software subject to the delayed release provisions of subparagraph (d)(4) below. The Grantee shall promptly deliver to the Contracting Officer or to the Patent Counsel designated by the Contracting Officer a duly executed and approved instrument fully confirmatory of all rights to which the Government is entitled, and other terms pertaining to the computer software to which claim to copyright is made.

(4) Except for such data which (1) generally known or available from other sources without obligation concerning its confidentiality, (2) has been made available by the owner to others without obligation concerning its confidentiality, (3) is otherwise already available to the Government without obligation concerning its confidentiality, and/or (4) is Limited Rights Data as set forth in subparagraph (g) of this clause, the Government will have the right to release technical data delivered in performance of this contract 5 years after the conclusion of this grant, or termination of the recoupment agreement, whichever is later, except that in the interim disclosure or use on a limited basis may be made solely for the following purposes unless a limited basis disclosure will not fulfill the purpose of the release:

(i) As required for evaluation purposes by other than commercial competitors of Grantee or its subcontractors selected in phase II to the extent necessary to fulfill other contract requirements;

(ii) As required for deposit with the Technical Information Center (TIC) and/or the National Energy Software Center (NESC), where applicable;

(iii) As required under the Freedom of Information Act (5 U.S.C. 552), and other applicable laws or regulations, if any; and

(iv) As required to meet the Government's obligations under international agreements and treaties.

(5) The Grantee agrees to submit to the Contracting Officer, by the end of Phase 2, for approval by DOE a list of data not subject to the provisions of subparagraph (d)(4) above, which data shall be immediately available to the public.

(6) The terms and conditions of subparagraphs (d)(1)-(4), above shall not be included in subcontracts without the prior written approval of the Contracting Officer.

(e) Withholding of proprietary data.

Notwithstanding the inclusion of the "Additional Technical Data Requirements" article in this grant or any provision of this grant specifying the delivery of technical data, the Grantee may withhold proprietary data from delivery, provided that the Grantee furnishes in lieu of any such proprietary data so withheld technical data disclosing the source, size, configuration, mating and attachment characteristics, functional characteristics and performance requirements ("Form, Fit and Function" data, e.g., specification control drawings, catalog sheets, envelope drawings, etc.) or a general description of such proprietary data where "Form, Fit and Function" data are not applicable. The Government shall acquire no rights to any proprietary data so withheld except that such data shall be subject to the "inspection rights" Provisions of paragraph (f), and, if included, the "Limited rights in proprietary data" provisions of paragraph (g) and the "Grantee licensing" provisions of paragraph (h).

(f) Inspection rights.

Except as may be otherwise specified in this grant for specific items of Proprietary data which are not subject to this paragraph, the Contracting Officer's representatives, at all reasonable times up to three (3) years after final payment under this grant, may inspect at the Grantee's facility any proprietary data withheld under paragraph (e) and not furnished under paragraph (g), if included, for the purposes of verifying that such data properly fell within the withholding provision of paragraph (e), or for evaluating work performance.

(g) Limited rights in proprietary data - (July, 1977)

Except as may be otherwise specified in this contract as technical data which are not subject to this Paragraph, the Contractor shall, upon written request from the Contracting Officer at any time prior to three (3) years after final payment under this contract, promptly deliver to the Government any "proprietary data" withheld pursuant to paragraph (e) of the "Rights in Technical Data" clause of this contract. The following legend and no other is authorized to be affixed on any "proprietary data" delivered pursuant to this provision, provided the "proprietary data" meets the conditions for initial withholding under paragraph (e) of the "Rights in Technical Data" clause. The Government will thereafter treat the "proprietary data" in accordance with such legend.

LIMITED RIGHTS LEGEND

> This "proprietary data", furnished under Contract No. ____________ ______________ with the United States Department of Energy (and purchase order No. ________________________ if applicable) may be duplicated and used by the Government with the express limitations that the "proprietary data" may not be disclosed outside the Government or be used for purposes of manufacture without prior permission of the Contractor, except that further disclosure or use may be made solely for the following purposes:
>
> This "proprietary data" may be disclosed to other than commercial competitors of Grantee or its subcontractors selected in phase 2 for evaluation purposes under the restriction that the "proprietary data" be retained in confidence and not be further disclosed;
>
> This legend shall be marked on any reproduction of this data in whole or in part.

(h) Contracting Under this Grant.

It is the responsibility of the Grantee to obtain from its contractors hereunder technical data and rights therein, on behalf of the Government, necessary to fulfill the Grantee's obligations to the Government with respect to such data. In the event of refusal by a contractor hereunder to accept an article affording the Government such rights, the Grantee shall:

(1) Promptly submit written notice to the Contracting Officer setting forth reasons for said contractor refusal and other pertinent information which may expedite disposition of the matter; and

(2) Not proceed with said contract without the written authorization of the Contracting Officer.

(i) Contractor licensing.

Except for small business firms or non-profit organizations, this clause shall be applicable if the Grantee should assert a proprietary claim in connection with a request for data under Article 5, Additional Technical Data Requirements, Article 6, Rights in Technical Data, and/or Appendix A, paragraph 8 and Appendix D-2, Program Deliverables of this grant:

Except as may be otherwise specified in this grant as technical data not subject to this paragraph, provided that the FOAKE technology is developed to the point of practical application under this grant and is not available for sale in the United States, the Grantee agrees that upon written application by DOE, it will grant to the Government and responsible third parties, for purposes of practicing a subject of this grant, a nonexclusive license in any limited rights data, on terms and conditions reasonable under the circumstances including appropriate provisions for confidentiality; provided, however, the Grantee shall not be obligated to license any such data if the Grantee demonstrates to the satisfaction of the Head of the Agency or designee that:

(1) Such data are not essential to the manufacture or practice of hardware designed or fabricated, or processes developed, under this contract;

(2) Such data, in the form of results obtained by their use, have a commercially competitive alternative available or readily introducible from one or more other sources;

(3) Such data, in the form of results obtained by their use, are being supplied by the contractor or its licensees in sufficient quantity and at reasonable prices to satisfy market needs, or the contractor or its licensees have taken effective steps or within a reasonable time are expected to take effective steps to so supply such data in the form of results obtained by its use; or

(4) Such data, in the form of results obtained by their use, can be furnished by another firm skilled in the art of manufacturing items or performing processes of the same general type and character necessary to achieve the contract results.

The Grantee shall include in all subcontracts the requirements of this provision excluding the requirement that the FOAKE technology be developed to the point of practicle application under this grant and is not available for sale in the United States, prior to the granting of a nonexclusive license to the government and responsible third parties. The provision for any individual Subcontractor should be sufficiently modified to conform with any other preexisting DOE contract, if any, entered into by the Subcontractor requiring background data licensing in the subject technology.

ARTICLE 7. RIGHTS TO PROPOSAL DATA

Is is agreed that as a condition of the award of this grant or modification thereto, and notwithstanding the provisions of any notice appearing on the proposal(s), the Government shall have the right to use, duplicate, and disclose and have others to do so for any purpose whatsoever, the technical data contained in the proposal(s) upon which this grant or modification is based.

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APPENDIX C

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